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PROCEEDINGS

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FIFTY-FIFTH MEETING

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CONTENTS.

PAGE.

Officers of the New Orleans Meeting 5
Members of the Council of the New Orleans Meeting . . . 7
Local Committee of the New Orleans Meeting 8
Officers for the Ithaca and New York Meetings 10
Members of the Council for the Ithaca and New York Meetings 12
Special Committees of the Association 13
Meetings and Officers of the Association of American Geologists and Naturalists 15
List of Meetings of the Association 16
Officers of the Meetings of the Association 17
Act of Incorporation 28
Constitution 29
Members of the Association
Surviving Founders 40
Patrons 40
Honorary Fellows 40
Members and Fellows 41
Incorporated Scientific Bodies 207
Deceased Members 208

IN GENERAL SESSION.

ADDRESS OF W. G. FARLOW, THE RETIRING PRESIDENT OF THE ASSOCIATION 213

SECTION A. MATHEMATICS AND ASTRONOMY.

OFFICERS OF SECTION A 236
ADDRESS OF VICE-PRESIDENT ALEXANDER ZIWET . . . 237
REPORT OF THE SECRETARY 249

SECTION B. PHYSICS.

OFFICERS OF SECTION B 256
ADDRESS OF VICE-PRESIDENT WM. F. MAGIE 257
REPORT OF THE SECRETARY 287

SECTION C. CHEMISTRY.

OFFICERS OF SECTION C 296
ADDRESS OF VICE-PRESIDENT LEONARD P. KINNICUTT . . 297
REPORT OF THE SECRETARY 313

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SECTION D. MECHANICAL SCIENCE AND ENGINEERING.

PAGE.

OFFICERS OF SECTION D 338
ADDRESS OF VICE-PRESIDENT D. S. JACOBUS 339
REPORT OF THE SECRETARY 349

SECTION E. GEOLOGY AND GEOGRAPHY.

OFFICERS OF SECTION E 356
ADDRESS OF VICE-PRESIDENT EUGENE A. SMITH . . 357
REPORT OF THE SECRETARY 375

SECTION F. ZOOLOGY.

OFFICERS OF SECTION F 382
ADDRESS OF VICE-PRESIDENT C. HART MERRIAM . . . 383
REPORT OF THE SECRETARY 409

SECTION G. BOTANY.

OFFICERS OF SECTION G 416
ADDRESS OF VICE-PRESIDENT B. L. ROBINSON . . . 417
REPORT OF THE SECRETARY 437

SECTION H. ANTHROPOLOGY.

OFFICERS OF SECTION H 446
ADDRESS OF VICE-PRESIDENT WALTER HOUGH . . . 447
REPORT OF THE SECRETARY 455

SECTION I. SOCIAL AND ECONOMIC SCIENCE.

OFFICERS OF SECTION I 458
ADDRESS OF VICE-PRESIDENT MARTIN A. KNAPP . . 459
REPORT OF THE SECRETARY 471

SECTION K. PHYSIOLOGY AND EXPERIMENTAL MEDICINE.

OFFICERS OF SECTION K 496
ADDRESS OF VICE-PRESIDENT WM. T. SEDGWICK . . 497
REPORT OF THE SECRETARY 507

EXECUTIVE PROCEEDINGS.

REPORT OF THE GENERAL SECRETARY 543
REPORT OF THE TREASURER 556
REPORT OF THE PERMANENT SECRETARY 560
CASH ACCOUNT OF THE PERMANENT SECRETARY . 562–564

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THEODORE GILL, *Chairman*, A. S. PACKARD, C. O. WHITMAN, S. H. GAGE, H. C. BUMPUS, C. H. EIGENMANN.

[1] All Committees are expected to present their reports to the COUNCIL not later than the third day of the meeting. Committees sending their reports to the Permanent Secretary one month before a meeting can have them printed for use at the meeting.

11. *Committee on the Teaching of Anthropology in America.*

W J McGEE, *Chairman*, G. G. MACCURDY, FRANZ BOAS, W. H. HOLMES. ————

12. *Committee on the Relations of the Journal "Science" with the Association.*

SIMON NEWCOMB, *Chairman*, G. K. GILBERT, J. MCK. CATTELL, THE PRESIDENT, THE PERMANENT SECRETARY, THE TREASURER.

13. *Committee on the Relations of Plants and Climate.*

WILLIAM TRELEASE, *Chairman*, D. T. MACDOUGAL, J. M. COULTER.

14. *Committee on the Atomic Weight of Thorium.*

CHARLES BASKERVILLE, *Chairman*, F. P. VENABLE, JAMES LEWIS HOWE.

15. *Committee on the Velocity of Light*

W. S. FRANKLIN, *Chairman*, E. F. NICHOLS. ————

MEETINGS AND OFFICERS OF THE ASSOCIATION OF AMERICAN GEOLOGISTS AND NATURALISTS.

Meeting.	Date.	Place.	Chairman.	Secretary.	Assistant Secretary.	Treasurer.
1st	April 2, 1840,	Philadelphia,	Edw. Hitchcock,*	L. C. Beck,*		
2d	April 5, 1841,	Philadelphia,	Benj. Silliman,*	L. C. Beck,*	{B. Silliman, Jr.,* {C. B. Trego,*	
3d	April 25, 1842,	Boston,	S. G. Morton,*	C. T. Jackson,*	{J. D. Whitney,* {M. B. Williams,*	
4th	April 26, 1843,	Albany,	Henry D. Rogers,*	B. Silliman, Jr.,*		John Locke.*
5th	May 8, 1844,	Washington,	John Locke,*	{B. Silliman, Jr.,* {O. P. Hubbard,		Douglas Houghton.*
6th	April 30, 1845,	New Haven,	Wm. B. Rogers,*	{B. Silliman, Jr.,* {J. Law. Smith,*		Douglas Houghton.*
7th	Sept. 2, 1846,	New York,	C. T. Jackson,*	B. Silliman, Jr.,*		E. C. Herrick.*
8th	Sept. 20, 1847,	Boston,	Wm. B. Rogers,*†	Jeffries Wyman,*		B. Silliman, Jr.*

* Deceased.

† Professor Rogers, as chairman of this last meeting, called the first meeting of the new Association to order and presided until it was fully organized by the adoption of a constitution. As he was thus the first presiding officer of the new Association, it was directed at the Hartford meeting that his name be placed at the head of the Past Presidents of the American Association for the Advancement of Science.

Meetings	Place	Date	Members in attendance	Number of members
1	Philadelphia	Sept. 20, 1848	?	461
2	Cambridge	Aug. 14, 1849	?	540
3	Charleston	Mar. 12, 1850	?	622
4	New Haven	Aug. 19, 1850	?	704
5	Cincinnati	May 5, 1851	87	800
6	Albany	Aug. 19, 1851	194	769
7	Cleveland	July 28, 1853	?	940
8	Washington	April 26, 1854	168	1004
9	Providence	Aug. 15, 1855	166	605
10	2d Albany	Aug. 20, 1856	381	722
11	Montreal	Aug. 12, 1857	351	946
12	Baltimore	April 28, 1858	190	962
13	Springfield	Aug. 3, 1859	190	862
14	Newport	Aug. 1, 1860	135	644
15	Buffalo	Aug. 15, 1866	79	637
16	Burlington	Aug. 21, 1867	73	415
17	Chicago	Aug. 5, 1868	259	686
18	Salem	Aug. 18, 1869	244	511
19	Troy	Aug. 17, 1870	188	536
20	Indianapolis	Aug. 16, 1871	196	668
21	Dubuque	Aug. 15, 1872	164	610
22	Portland	Aug. 20, 1873	195	670
23	Hartford	Aug. 12, 1874	224	722
24	Detroit	Aug. 11, 1875	165	807
25	2d Buffalo	Aug. 23, 1876	215	867
26	Nashville	Aug. 29, 1877	173	953
27	St. Louis	Aug. 21, 1878	134	962
28	Saratoga	Aug. 27, 1879	256	1030
29	Boston	Aug. 25, 1880	997	1555
30	2d Cincinnati	Aug. 17, 1881	500	1699
31	2d Montreal	Aug. 23, 1882	937	1922
32	Minneapolis	Aug. 15, 1883	328	2033
33	2d Philadelphia	Sept. 3, 1884	1261*	1981
34	Ann Arbor	Aug. 26, 1885	364	1956
35	3d Buffalo	Aug. 18, 1886	445	1886
36	New York	Aug. 10, 1887	729	1956
37	2d Cleveland	Aug. 14, 1888	342	1964
38	Toronto	Aug. 26, 1889	424	1952
39	2d Indianapolis	Aug. 19, 1890	364	1944
40	2d Washington	Aug. 19, 1891	653†	2054
41	Rochester	Aug. 17, 1892	456	2037
42	Madison	Aug. 17, 1893	290	1939
43	Brooklyn	Aug. 15, 1894	488	1802
44	2d Springfield	Aug. 28, 1895	368	1913
45	4th Buffalo	Aug. 24, 1896	333	1890
46	2d Detroit	Aug. 9, 1897	283‡	1782
47	2d Boston	Aug. 22, 1898	903	1729
48	Columbus	Aug. 21, 1899	353	1721
49	2d New York	June 25, 1900	434	1925
50	Denver	Aug. 24, 1901	311	2703
51	Pittsburg	June 28 to July 3, 1902	435	3473
52	3d Washington	Dec. 27, 1902, to Jan. 2, 1903	975	3596
53	2d St. Louis	Dec. 28, 1903, to Jan. 2, 1904	385	4075
54	3d Philadelphia	Dec. 27-31, 1904	890	4175
55	New Orleans	Dec. 28, 1905, to Jan. 2, 1906	233	4357

* Including 303 Members of the British Association and 9 other foreign guests.

† Including 24 Foreign Honorary Members for the meeting.

‡ Including 15 Foreign Honorary Members and Associates for the meeting.

Officers of the Meetings of the Association.

[The number before the name is that of the meeting; the year of the meeting follows the name; the asterisk after a name indicates that the member is deceased.]

PRESIDENTS.

1. WM. B. ROGERS,* 1848. W. C. REDFIELD,* 1848.
2. JOSEPH HENRY,* 1849.
3. A. D. BACHE,* March meeting, 1850, in the absence of JOSEPH HENRY.*
4. August meeting, 1850.
5. May meeting, 1851.
6. LOUIS AGASSIZ,* August meeting, 1851. (No meeting in 1852.)
7. BENJAMIN PIERCE,* 1853.
8. JAMES D. DANA,* 1854.
9. JOHN TORREY,* 1855.
10. JAMES HALL,* 1856.
11. ALEXIS CASWELL,* 1857, in place of J. W. BAILEY,* deceased. 1858, in the absence of JEFFRIES WYMAN.*
12.
13. STEPHEN ALEXANDER,* 1859.
14. ISAAC LEA,* 1860. (No meetings for 1861–65.)
15. F. A. P. BARNARD,* 1866.
16. J. S. NEWBERRY,* 1867.
17. B. A. GOULD,* 1868.
18. J. W. FOSTER,* 1869.
19. T. STERRY HUNT,* 1870, in the absence of WM. CHAUVENET.*
20. ASA GRAY,* 1871.
21. J. LAWRENCE SMITH,* 1872.
22. JOSEPH LOVERING,* 1873.
23. J. L. LECONTE,* 1874.
24. J. E. HILGARD,* 1875.
25. WILLIAM B. ROGERS,* 1876.
26. SIMON NEWCOMB, 1877.
27. O. C. MARSH,* 1878.
28. G. F. BARKER, 1879.
29. LEWIS H. MORGAN,* 1880.
30. G. J. BRUSH, 1881.
31. J. W. DAWSON, 1882.
32. C. A. YOUNG, 1883.
33. J. P. LESLEY,* 1884.
34. H. A. NEWTON,* 1885.
35. EDWARD S. MORSE, 1886.
36. S. P. LANGLEY,* 1887.
37. J. W. POWELL,* 1888.
38. T. C. MENDENHALL, 1889.
39. G. LINCOLN GOODALE, 1890.
40. ALBERT B. PRESCOTT,* 1891.
41. JOSEPH LECONTE,* 1892.
42. WILLIAM HARKNESS,* 1893.
43. DANIEL G. BRINTON,* 1894.
44. E. W. MORLEY, 1895.
45. EDWARD D. COPE,* 1896. THEODORE GILL, as senior vice-president acted after the death of Prof. COPE.
46. WOLCOTT GIBBS, 1897, absent. W. J. MCGEE, Acting President.
47. F. W. PUTNAM, 1898.
48. EDWARD ORTON,* 1899. GROVE K. GILBERT, elected by the General Committee December, 1899, to fill the vacancy caused by the death of Prof. ORTON.
49. R. S. WOODWARD, 1900.
50. C. S. MINOT, 1901.
51. ASAPH HALL, 1902.
52. IRA REMSEN, 1903.
53. CARROLL D. WRIGHT, 1904.
54. W. G. FARLOW, 1905.
55. C. M. WOODWARD, 1906
56. W. H. WELCH, 1906.

VICE-PRESIDENTS.

There were no Vice-Presidents until the 11th meeting when there was a single Vice-President for each meeting. At the 24th meeting, the Association met in Sections A and B, each presided over by a Vice-President. At the 31st meeting nine sections were organized, each with a Vice-President as its presiding officer. In 1886 Section G (Microscopy) was given up. In 1892, Section F was divided into F, Zoology; G, Botany.

1857–1874.

11. ALEXIS CASWELL,* 1857, acted as President.
12. JOHN E. HOLBROOK,* 1858, not present.
13. EDWARD HITCHCOCK,* 1859.
14. B. A. GOULD,* 1860.
15. B. A. GOULD,* 1866, in the absence of R. W. GIBBES.
16. WOLCOTT GIBBS, 1867.
17. CHAS. WHITTLESEY,* 1868.
18. OGDEN N. ROOD, 1869.
19. T. STERRY HUNT,* 1870. acted as President.
20. G. F. BARKER, 1871.
21. ALEX. WINCHELL,* 1872.
22. A. H. WORTHEN,* 1873, not present.
23. C. S. LYMAN,* 1874.

1875–1881.

Section A.—Mathematics, Physics, and Chemistry.

24. H. A. NEWTON,* 1875.
25. C. A. YOUNG, 1876.
26. R. H. THURSTON,* 1877, in the absence of E. C. PICKERING.
27. R. H. THURSTON,* 1878.
28. S. P. LANGLEY,* 1879.
29. ASAPH HALL, 1880.
30. WM. HARKNESS,* 1881, in the absence of A. M. MAYER.*

Section B.—Natural History.

24. J. W. DAWSON, 1875.
25. EDWARD S. MORSE, 1876.
26. O. C. MARSH,* 1877.
27. AUG. R. GROTE, 1878.
28. J. W. POWELL,* 1879.
29. ALEX. AGASSIZ, 1880.
30. EDWARD T. COX, 1881, in the absence of GEORGE ENGELMANN.*

CHAIRMEN OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. S. W. JOHNSON, 1875.
25. G. F. BARKER, 1876.
26. N. T. LUPTON,* 1877.
27. F. W. CLARKE, 1878.
28. F. W. CLARKE, 1879, in the absence of IRA REMSEN.
29. J. M. ORDWAY, 1880.
30. G. C. CALDWELL, 1881, in the absence of W. R. NICHOLS.*

Subsection of Microscopy.

25. R. H. WARD, 1876.
26. R. H. WARD, 1877.
27. R. H. WARD, 1878, in the absence of G. S. BLACKIE.*
28. E. W. MORLEY, 1879.
29. S. A. LATTIMORE, 1880.
30. A. B. HERVEY, 1881.

Subsection of Anthropology.

24. LEWIS H. MORGAN,* 1875.
25. LEWIS H. MORGAN,* 1876.
26. DANIEL WILSON,* 1877, not present.
27. United with Section B.
28. DANIEL WILSON,* 1879.
29. J. W. POWELL,* 1880.
30. GARRICK MALLERY,* 1881.

Subsection of Entomology.

30. J. G. MORRIS,* 1881.

VICE-PRESIDENTS OF SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. W. A. ROGERS,* 1882, in the absence of WM. HARKNESS.*
32. W. A. ROGERS,* 1883.
33. H. T. EDDY, 1884.
34. WM. HARKNESS,* 1885, in the absence of J. M. VAN VLECK.
35. J. W. GIBBS,* 1886.
36. J. R. EASTMAN, 1887, in place of W. FERREL,* res'd.
37. ORMOND STONE, 1888.
38. R. S. WOODWARD, 1889.
39. S. C. CHANDLER, 1890.
40. E. W. HYDE, 1891.
41. J. R. EASTMAN, 1892.
42. C. L. DOOLITTLE, 1893.
43. { G. C. COMSTOCK, 1894. / EDGAR FRISBY, 1894.
44. EDGAR FRISBY, 1895, in place of E. H. HOLDEN, resigned.
45. ALEX. MACFARLANE, 1896, in place of WM. E. STORY, resigned.
46. W. W. BEMAN, 1897.
47. E. E. BARNARD, 1898.
48. ALEX. MACFARLANE, 1899.
49. ASAPH HALL, JR., 1900.
50. JAMES MACMAHON, 1901.
51. G. W. HOUGH, 1902.
52. GEORGE BRUCE HALSTED, 1903.
53. O. H. TITTMANN, 1904.
54. ALEXANDER ZIWET, 1905.
55. ALEXANDER ZIWET, 1906, in the absence of W. S. EICHELBERGER.
56. EDWARD KASNER, 1907.

Section B.—Physics.

31. T. C. MENDENHALL, 1882.
32. H. A. ROWLAND,* 1883.
33. J. TROWBRIDGE, 1884.
34. S. P. LANGLEY,* 1885, in place of C. F. BRACKETT, res'd.
35. C. F. BRACKETT, 1886.
36. W. A. ANTHONY, 1887
37. A. A. MICHELSON, 1888.
38. H. S. CARHART, 1889.
39. CLEVELAND ABBE, 1890.
40. F. E. NIPHER, 1891.
41. B. F. THOMAS, 1892.
42. E. L. NICHOLS, 1893.
43. WM. A. ROGERS, 1894.
44. W. LECONTE STEVENS, 1895.
45. CARL LEO MEES, 1896.
46. CARL BARUS, 1897.
47. F. P. WHITMAN, 1898.
48. ELIHU THOMSON, 1899.
49. ERNEST MERRITT, 1900.
50. D. B. BRACE,* 1901.
51. W. S. FRANKLIN, 1902.
52. ERNEST F. NICHOLS, 1903.
53. E. H. HALL, 1904.
54. WM. F. MAGIE, 1905.
55. HENRY CREW, 1906.
56. W. C. SABINE, 1907.

Section C.—Chemistry.

31. H. C. BOLTON,* 1882.
32. E. W. MORLEY, 1883.
33. J. W. LANGLEY, 1884.
34. N. T. LUPTON,* 1885, in the absence of W. R. NICHOLS.
35. H. W. WILEY, 1886.
36. A. B. PRESCOTT,* 1887.
37. C. E. MUNROE, 1888.
38. W. L. DUDLEY, 1889.
39. R. B. WARDER, 1890.
40. R. C. KEDZIE, 1891.
41. ALFRED SPRINGER, 1892.
42. EDWARD HART, 1893.
43. T. H. NORTON, 1894.
44. WM. MCMURTRIE, 1895.
45. W. A. NOYES, 1896.
46. W. P. MASON, 1897.
47. EDGAR F. SMITH, 1898.
48. F. P. VENABLE, 1899.
49. JAS. LEWIS HOWE, 1900.
50. JOHN H. LONG, 1901.
51. H. A. WEBER, 1902.
52. CHARLES BASKERVILLE, 1903.

VICE-PRESIDENTS OF SECTIONS, CONTINUED.

53. W. D. BANCROFT, 1904.
54. L. P. KINNICUTT, 1905.
55. L. P. KINNICUTT, 1906, in absence of C. F. MABERY.
56. CLIFFORD RICHARDSON, 1907.

Section D.—Mechanical Science and Engineering.

31. W. P. TROWBRIDGE,* 1882.
32. DEVOLSON WOOD, 1883, absent, but place was not filled.
33. R. H. THURSTON,* 1884.
34. J. BURKITT WEBB, 1885.
35. O. CHANUTE, 1886.
36. E. B. COXE, 1887.
37. C. J. H. WOODBURY, 1888.
38. JAMES E. DENTON, 1889.
39. JAMES E. DENTON, 1890, in place of A. BEARDSLEY, absent.
40. THOMAS GRAY, 1891.
41. J. B. JOHNSON, 1892.
42. S. W. ROBINSON, 1893.
43. MANSFIELD MERRIMAN, 1894.
44. WILLIAM KENT, 1895.
45. FRANK O. MARVIN, 1896.
46. JOHN GALBRAITH, 1897.
47. JOHN GALBRAITH, 1898, in the absence of M.E.COOLEY.
48. STORM BULL, 1899.
49. JOHN A. BRASHEAR, 1900.
50. H. S. JACOBY, 1901.
51. J. J. FLATHER, 1902.
52. CLARENCE A. WALDO, 1903.
53. C. M. WOODWARD, 1904.
54. C. M. WOODWARD, 1905, in the absence of D. S. JACOBUS.
55. F. W. MCNAIR, 1906.
56. W. R. WARNER, 1907.

Section E.—Geology and Geography.

31. E. T. COX, 1882.
32. C. H. HITCHCOCK, 1883.
33. N. H. WINCHELL, 1884.
34. EDWARD ORTON,* 1885.
35. T. C. CHAMBERLIN, 1886.
36. G. K. GILBERT, 1887.
37. GEORGE H. COOK,* 1888.
38. CHARLES A. WHITE, 1889.
39. JOHN C. BRANNER, 1890.
40. J. J. STEVENSON, 1891.
41. H. S. WILLIAMS, 1892.
42. CHARLES D. WALCOTT, 1893.
43. SAMUEL CALVIN, 1894.
44. JED. HOTCHKISS, 1895.
45. B. K. EMERSON, 1896.
46. { I. C. WHITE, 1897. E. W. CLAYPOLE,* 1897.
47. H. L. FAIRCHILD, 1898.
48. J. F. WHITEAVES, 1899.
49. J. F. KEMP, 1900.
50. C. R. VAN HISE, 1901.
51. JOSEPH A. HOLMES, 1902, in the absence of O. A. DERBY.
52. WM. M. DAVIS, 1903.
53. I. C. RUSSELL, 1904.
54. EUGENE A. SMITH, 1905.
55. WM. NORTH RICE, 1906.
56. A. C. LANE, 1907.

Section F.—Biology, 1882–1892.

31. W. H. DALL, 1882.
32. W. J. BEAL, 1883.
33. E. D. COPE,* 1884.
34. T. J. BURRILL, 1885, in the absence of B. G. WILDER.
35. H. P. BOWDITCH, 1886.
36. W. G. FARLOW, 1887.
37. C. V. RILEY,* 1888.
38. GEORGE L. GOODALE, 1889.
39. C. S. MINOT, 1890.
40. J. M. COULTER, 1891.
41. S. H. GAGE, 1892.

Section F.—Zoology.

42. HENRY F. OSBORN, 1893.
43. J. A. LINTNER,* 1894, in place of S. H. SCUDDER, res'd.
44. L. O. HOWARD, 1895, in place of D. S. JORDAN, res'd.
45. THEO. GILL, 1896.
46. L. O. HOWARD, 1897, in place of G. BROWN GOODE,* deceased.
47. A. S. PACKARD,* 1898.

VICE-PRESIDENTS OF SECTIONS, CONTINUED.

48. S. H. GAGE, 1899.
49. C. B. DAVENPORT, 1900.
50. D. S. JORDAN, 1901.
51. E. L. MARK, 1902, in the absence of C. C. NUTTING.
52. C. W. HARGITT, 1903.
53. E. L. MARK, 1904.
54. C. HART MERRIAM, 1905.
55. H. B. WARD, 1906.
56. E. G. CONKLIN, 1907.

Section G. Microscopy, 1882–85.

31. A. H. TUTTLE, 1882.
32. J. D. COX, 1883.
33. T. G. WORMLEY,* 1884.
34. S. H. GAGE, 1885.

(Section united with F in 1886.)

Section G.—Botany.

42. CHARLES E. BESSEY, 1893.
43. L. M. UNDERWOOD, 1894. C. E. BESSEY, 1894.
44. J. C. ARTHUR, 1895.
45. N. L. BRITTON, 1896.
46. G. F. ATKINSON, 1897.
47. W. G. FARLOW, 1898.
48. C. R. BARNES, 1899.
49. W. TRELEASE, 1900.
50. B. T. GALLOWAY, 1901.
51. C. E. BESSEY, 1902, in the absence of D. H. CAMPBELL.
52. F. V. COVILLE, 1903.
53. T. H. MACBRIDE, 1904.
54. B. L. ROBINSON, 1905.
55. B. L. ROBINSON, 1906, in the absence of ERWIN F. SMITH,
56. D. T. MAC DOUGALL, 1907.

Section H.—Anthropology.

31. ALEX. WINCHELL,* 1882.
32. OTIS T. MASON, 1883.
33. EDWARD S. MORSE, 1884.
34. J. OWEN DORSEY,* 1885, in the absence of W. H. DALL.
35. HORATIO HALE,* 1886.
36. D. G. BRINTON,* 1887.
37. CHARLES C. ABBOTT, 1888.
38. GARRICK MALLERY,* 1889.
39. FRANK BAKER, 1890.
40. JOSEPH JASTROW, 1891.
41. W. H. HOLMES, 1892.
42. J. OWEN DORSEY,* 1893.
43. FRANZ BOAS, 1894.
44. F. H. CUSHING,* 1895.
45. ALICE C. FLETCHER, 1896.
46. W J MCGEE, 1897.
47. J. MCK. CATTELL, 1898.
48. THOMAS WILSON,* 1899.
49. A. W. BUTLER, 1900.
50. J. WALTER FEWKES, 1901.
51. STEWART CULIN, 1902.
52. GEO. A. DORSEY, 1903.
53. M. H. SAVILLE, 1904.
54. WALTER HOUGH, 1905.
55. GEORGE GRANT MCCURDY. 1906.
56. HUGO MUNSTERBERG, 1907.

Section I.—Social and Economic Science.

31. E. B. ELLIOTT,* 1882.
32. FRANKLIN B. HOUGH,* 1883.
33. JOHN EATON,* 1884.
34. EDWARD ATKINSON, 1885.
35. JOSEPH CUMMINGS,* 1886.
36. H. E. ALVORD,* 1887.
37. CHARLES W. SMILEY, 1888.
38. CHARLES S. HILL, 1889.
39. J. RICHARDS DODGE, 1890.
40. EDMUND J. JAMES, 1891.
41. L. F. WARD, 1892, in place of S. D. HORTON,* resigned.
42. WILLIAM H. BREWER, 1893.
43. HENRY FARQUHAR, 1894.
44. B. E. FERNOW, 1895.
45. W. L. LAZENBY, 1896.
46. R. T. COLBURN, 1897.
47. ARCHIBALD BLUE, 1898.
48. MARCUS BENJAMIN, 1899.
49. MARCUS BENJAMIN, 1900, in the absence of C. M. WOODWARD.
50. JOHN HYDE, 1901.
51. JOHN HYDE, 1902, in the absence of CARROLL D. WRIGHT.

VICE-PRESIDENTS OF THE SECTIONS, CONTINUED.

52. H. T. NEWCOMB, 1903.
53. SIMEON E. BALDWIN, 1904.
54. MARTIN A. KNAPP, 1905.
55. IRVING FISHER, 1906.
56. CHAS. A. CONANT, 1907.

Section K.—Physiology and Experimental Medicine.

51. W. H. WELCH, 1902.
52. W. H. WELCH, 1903.
53. H. P. BOWDITCH, 1904.
54. H. P. BOWDITCH, 1905.
55. ALEXANDER C. ABBOTT, 1906, in the absence of W. T. SEDGWICK.
56. SIMON FLEXNER, 1907.

SECRETARIES.

General Secretaries, 1848–

1. WALTER R. JOHNSON,* 1848
2. E. N. HORSFORD,* 1849, in the absence of JEFFRIES WYMAN.*
3. L. R. GIBBS, 1850, in the absence of E. C. HERRICK*
4. E. C. HERRICK,* 1850.
5. WM. B. ROGERS,* 1851, in the absence of E. C. HERRICK.*
6. WM. B. ROGERS,* 1851.
7. S. ST. JOHN,* 1853, in the absence of J. D. DANA.*
8. J. LAWRENCE SMITH,* 1854.
9. WOLCOTT GIBBS, 1855.
10. B. A. GOULD,* 1856.
11. JOHN L. LECONTE,* 1857.
12. W. M. GILLESPIE,* 1858, in the absence of WM. CHAUVENET.*
13. WM. CHAUVENET,* 1859.
14. JOSEPH LECONTE,* 1860.
15. ELIAS LOOMIS,* 1866, in the absence of W. P. TROWBRIDGE.*
16. C. S. LYMAN,* 1867.
17. SIMON NEWCOMB, 1868, in the absence of A. P. ROCKWELL.
18. O. C. MARSH,* 1869.
19. F. W. PUTNAM, 1870, in the absence of C. F. HARTT.*
20. F. W. PUTNAM, 1871.
21. EDWARD S. MORSE, 1872.
22. C. A. WHITE, 1873.
23. A. C. HAMLIN, 1874.
24. S. H. SCUDDER, 1875.
25. T. C. MENDENHALL, 1876.
26. AUG. R. GROTE, 1877.
27. H. C. BOLTON,* 1878.
28. H. C. BOLTON,* 1879, in the absence of GEORGE LITTLE.
29. J. K. REES, 1880.
30. C. V. RILEY,* 1881.
31. WILLIAM SAUNDERS, 1882.
32. J. R. EASTMAN, 1883.
33. ALFRED SPRINGER, 1884.
34. C. S. MINOT, 1885.
35. S. G. WILLIAMS,* 1886.
36. WILLIAM H. PETTEE, 1887.
37. JULIUS POHLMAN, 1888.
38. C. LEO MEES, 1889.
39. H. C. BOLTON.* 1890.
40. H. W. WILEY, 1891.
41. A. W. BUTLER, 1892.
42. T. H. NORTON, 1893.
43. H. L. FAIRCHILD, 1894.
44. JAS. LEWIS HOWE, 1895.
45. CHARLES R. BARNES, 1896.
46. ASAPH HALL, JR., 1897.
47. J. MCMAHON, 1898, in place of D. S. KELLICOTT,* deceased.
48. F. BEDELL, 1899.
49. CHAS. BASKERVILLE, 1900.
50. JOHN M. COULTER, 1901, in the absence of WILLIAM HALLOCK.
51. D. T. MACDOUGAL, 1902.
52. HENRY B. WARD, 1903.
53. C. W. STILES, 1904.
54. CHARLES S. HOWE, 1905.
55. C. A. WALDO, 1906.
56. JOHN F. HAYFORD, 1907.

Permanent Secretaries, 1851–

5–7. SPENCER F. BAIRD,* 1851–4
8–17. JOSEPH LOVERING,* 1854–68.
18. F. W. PUTNAM, 1869, in the absence of J. LOVERING.*

SECRETARIES, CONTINUED.

19–21. JOSEPH LOVERING,* 1870–73.
22–46. F. W. PUTNAM, 1873–98.
47–54. L. O. HOWARD, 1898–05.
55–59. L. O. HOWARD, 1906–10.

Assistant General Secretaries, 1882–1887.

31. J. R. EASTMAN, 1882.
32. ALFRED SPRINGER, 1883.
33. C. S. MINOT, 1884, in the absence of E. S. HOLDEN.
34. S. G. WILLIAMS,* 1885, in the absence of C. C. ABBOTT.
35. W. H. PETTEE, 1886.
36. J. C. ARTHUR, 1887.

Secretaries of the Council, 1888–

37. C. LEO MEES, 1888.
38. H. C. BOLTON,* 1889.
39. H. W. WILEY, 1890.
40. A. W. BUTLER, 1891.
41. T. H. NORTON, 1892.
42. H. LEROY FAIRCHILD, 1893.
43. JAS. LEWIS HOWE, 1894.
44. CHARLES R. BARNES, 1895.
45. ASAPH HALL, JR., 1896.
46. D. S. KELLICOTT,* 1897.
47. FREDERICK BEDELL, 1898.
48. CHARLES BASKERVILLE, 1899.
49. WILLIAM HALLOCK, 1900.
50. D. T. MACDOUGAL, 1901.
51. H. B. WARD, 1902.
52. CH. WARDELL STILES, 1903.
53. CHAS. S. HOWE, 1904.
54. C. A. WALDO, 1905.
55. JOHN T. HAYFORD, 1906.
56. F. W. MCNAIR, 1907.

Secretaries of Section A.—Mathematics, Physics and Chemistry, 1875–1881.

24. S. P. LANGLEY,* 1875. / T. C. MENDENHALL, 1875.
25. A. W. WRIGHT, 1876.
26. H. C. BOLTON,* 1877.
27. F. E. NIPHER, 1878.
28. J. K. REES, 1879.
29. H. B. MASON, 1880.
30. E. T. TAPPAN, 1881, in the absence of JNO. TROWBRIDGE.

Secretaries of Section B.—Natural History, 1874–1881.

24. EDWARD S. MORSE, 1875.
25. ALBERT H. TUTTLE, 1876.
26. WILLIAM H. DALL, 1877.
27. GEORGE LITTLE, 1878.
28. WM. H. DALL, 1879, in the absence of A. C. WETHERBY.
29. CHARLES V. RILEY,* 1880.
30. WILLIAM SAUNDERS, 1881.

SECRETARIES OF SUBSECTIONS, 1875–1881.

Subsection of Chemistry.

24. F. W. CLARKE, 1875.
25. H. C. BOLTON,* 1876.
26. P. SCHWEITZER, 1877.
27. A. P. S. STUART, 1878.
28. W. R. NICHOLS,* 1879.
29. C. E. MUNROE, 1880.
30. ALFRED SPRINGER, 1881, in the absence of R. B. WARDER.

Subsection of Entomology.

30. B. P. MANN, 1881.

Subsection of Anthropology.

24. F. W. PUTNAM, 1875.
25. OTIS T. MASON, 1876.
26, 27. United with Section B.
28, 29, 30. J. G. HENDERSON, 1879–81.

Subsection of Microscopy.

25. E. W. MORLEY, 1876.
26. T. O. SOMMERS, JR., 1877.
27. G. J. ENGELMANN, 1878.
28, 29. A. B. HERVEY, 1879–80.
30. W. H. SEAMAN, 1881, in the absence of S. P. SHARPLES.

SECRETARIES OF THE SECTIONS, 1882–

Section A.—Mathematics and Astronomy.

31. H. T. EDDY, 1882.
32. G. W. HOUGH, 1883, in the absence of W. W. JOHNSON.
33. G. W. HOUGH, 1884.
34. E. W. HYDE, 1885.
35. S. C. CHANDLER, 1886.
36. H. M. PAUL, 1887.
37. C. C. DOOLITTLE, 1888.
38. G. C. COMSTOCK, 1889.
39. W. W. BEMAN, 1890.
40. F. H. BIGELOW, 1891.
41. WINSLOW UPTON, 1892.
42. C. A. WALDO, 1893, in the absence of A. W. PHILLIPS.
43. J. C. KERSHNER, 1894, in place of W.W.BEMAN, res'd.
44. ASAPH HALL, JR., 1895, in place of E. H. MOORE, res'd.
45. EDWIN B. FROST, 1896.
46. JAMES MCMAHON, 1897.
47. WINSLOW UPTON, 1898, in place of ALEX. ZIWET, resigned.
48. JOHN F. HAYFORD, 1899.
49. W. M. STRONG, 1900.
50. G. A. MILLER, 1901, in place of H. C. LORD, resigned.
51. E. S. CRAWLEY, 1902.
52. C. S. HOWE, 1903.
53–57. L. G. WELD, 1904–1908.

Section B.—Physics.

31. C. S. HASTINGS, 1882.
32. F. E. NIPHER, 1883, in the absence of C. K. WEAD.
33. N. D. C. HODGES, 1884.
34. B. F. THOMAS, 1885, in place of A. A. MICHELSON, resigned.
35. H. S. CARHART, 1886.
36. C. LEO MEES, 1887.
37. ALEX. MACFARLANE, 1888.
38. E. L. NICHOLS, 1889.
39. E. M. AVERY, 1890.
40. ALEX. MACFARLANE, 1891.
41. BROWN AYRES, 1892.
42. W. LECONTE STEVENS, 1893.
43. B. W. SNOW, 1894.
44. E. MERRITT, 1895.
45. FRANK P. WHITMAN, 1896.
46. FREDERICK BEDELL, 1897.
47. W. S. FRANKLIN, 1898, in place of E. B. ROSA, resigned.
48. WILLIAM HALLOCK, 1899.
49. R. A. FESSENDEN, 1900.
50. JOHN ZELENY, 1901, in place of J. O. REED, resigned.
51. E. F. NICHOLS, 1902.
52. D. C. MILLER, 1903.
53–57. D. C. MILLER, 1904–1908.

Section C.—Chemistry.

31. ALFRED SPRINGER, 1882.
32. { J. W. LANGLEY, 1883. / W. MCMURTRIE, 1883.
33. H. CARMICHAEL, 1884, in the absence of R. B. WARDER.
34. F. P. DUNNINGTON, 1885.
35. W. MCMURTRIE, 1886.
36. C. F. MABERY, 1887.
37. W. L. DUDLEY, 1888.
38. EDWARD HART, 1889.
39. W. A. NOYES, 1890.
40. T. H. NORTON, 1891.
41. JAS. LEWIS HOWE, 1892.
42. H. N. STOKES, 1893, in the absence of J. U. NEF.
43. MORRIS LOEB, 1894, in place of S. M. BABCOCK, resigned.
44. { W. P. MASON, 1895. / W. O. ATWATER, 1895.
45. FRANK P. VENABLE, 1896.
46. P. C. FREER, 1897.
47. C. BASKERVILLE, 1898.
48. H. A. WEBER, 1899.
49. A. A. NOYES, 1900.
50. W. MCPHERSON, 1901.

SECRETARIES OF THE SECTIONS, CONTINUED.

51. F. C. PHILLIPS, 1902.
52. H. N. STOKES, 1903.
53–57. CHAS. L. PARSONS, 1904–1908.

Section D.—Mechanical Science and Engineering.

31. J. BURKITT WEBB, 1882, in the absence of C. B. DUDLEY.
32. J. BURKITT WEBB, 1883, *pro tempore.*
33. J. BURKITT WEBB, 1884.
34. C. J. H. WOODBURY, 1885.
35. WILLIAM KENT, 1886.
36. G. M. BOND, 1887.
37. ARTHUR BEARDSLEY, 1888.
38. W. B. WARNER, 1889.
39. THOMAS GRAY, 1890.
40. WILLIAM KENT, 1891.
41. O. H. LANDRETH, 1892.
42. D. S. JACOBUS, 1893.
43. JOHN H. KINEALY, 1894.
44. H. S. JACOBY, 1895.
45. JOHN GALBRAITH, 1896.
46. JOHN J. FLATHER, 1897.
47. JOHN J. FLATHER, 1898, in the absence of W. S. ALDRICH.
48. J. M. PORTER, 1899.
49. W. T. MAGRUDER, 1900.
50. C. W. COMSTOCK, 1901, in the absence of W. H. JAQUES.
51. C. A. WALDO, 1902.
52. ELWOOD MEAD, 1903, in the absence of ALBERT KINGSBURY.
53–57. W. T. MAGRUDER, 1904–1908.

Section E.—Geology and Geography.

31. H. S. WILLIAMS, 1882, in the absence of C. E. DUTTON.
32. A. A. JULIEN, 1883.
33. E. A. SMITH, 1884.
34. G. K. GILBERT, 1885, in the absence of H. C. LEWIS.*
35. E. W. CLAYPOLE,* 1886.
36. W. M. DAVIS, 1887, in the absence of T. B. COMSTOCK.
37. JOHN C. BRANNER, 1888.
38. JOHN C. BRANNER, 1889.
39. SAMUEL CALVIN, 1890.
40. W. J. MCGEE, 1891.
41. R. D. SALISBURY, 1892.
42. W. H. HOBBS,* 1893, in place of R. T. HILL, resigned.
43. JED. HOTCHKISS,* 1894, in place of W. M. DAVIS, res'd.
44. J. PERRIN SMITH, 1895.
45. W. N. RICE, 1896, in place of A. C. GILL, resigned.
46. C. H. SMITH, JR., 1897.
47. WARREN UPHAM, 1898.
48. ARTHUR HOLLICK, 1899.
49. J. A. HOLMES, 1900.
50. H. B. PATTON, 1901, in the absence of R. A. F. PENROSE.
51. F. P. GULLIVER, 1902.
52. E. O. HOVEY, 1903.
53. G. B. SHATTUCK, 1904.
54–57. EDMUND O. HOVEY, 1905–1908.

Section F.—Biology, 1882–1892.

31. WILLIAM OSLER, 1882, in the absence of C. S. MINOT.
32. S. A. FORBES, 1883.
33. C. E. BESSEY, 1884.
34. J. A. LINTNER,* 1885, in place of C. H. FERNALD, res'd
35. J. C. ARTHUR, 1886.
36. J. H. COMSTOCK, 1887.
37. B. E. FERNOW, 1888.
38. A. W. BUTLER, 1889.
39. J. M. COULTER, 1890.
40. A. J. COOK, 1891.
41. D. B. HALSTEAD, 1892.

Section F.—Zoology.

42. L. O. HOWARD, 1893.
43. JOHN B. SMITH, 1894, in place of WM. LIBBY, JR., resigned.

SECRETARIES OF THE SECTIONS, CONTINUED.

44. C. W. HARGITT, 1895, in place of S. A. FORBES, res'd.
45. D. S. KELLICOTT,* 1896.
46. C. C. NUTTING, 1897.
47. R. T. JACKSON, 1898, in place of C. W. STILES, resigned.
48. C. L. MARLATT, 1899, in place of F. W. TRUE, resigned.
49. C. H. EIGENMANN, 1900.
50. H. B. WARD, 1901.
51. C. W. STILES, 1902.
52. C. J. HERRICK, 1903.
53–57. C. J. HERRICK, 1904–08.

Section G.—Microscopy, 1882–85.

31. ROBERT BROWN, JR., 1882.
32. CARL SEILER, 1883.
33. ROMYN HITCHCOCK, 1884.
34. W. H. WALMSLEY, 1885.

Section G.—Botany.

42. B. T. GALLOWAY, 1893, in the absence of F. V. COVILLE.
43. CHAS. R. BARNES, 1894.
44. { B. T. GALLOWAY, 1895. M. B. WAITE, 1895.
45. GEORGE F. ATKINSON, 1896.
46. F. C. NEWCOMBE, 1897.
47. ERWIN F. SMITH, 1898.
48. W. A. KELLERMAN, 1899.
49. D. T. MACDOUGAL, 1900.
50. ERNST A. BESSEY, 1901, in the absence of A. S. HITCHCOCK.
51. H. VON SCHRENK, 1902.
52. C. J. CHAMBERLAIN, 1903.
53–57. F. E. LLOYD, 1904–1908.

Section H.—Anthropology.

31. OTIS T. MASON, 1882.
32. G. H. PERKINS, 1883.
33. G. H. PERKINS, 1884, in the absence of W. H. HOLMES.
34. ERMINNIE A. SMITH,* 1885.
35. A. W. BUTLER, 1886.
36. CHAS. C. ABBOTT, 1887, in the absence of F. W. LANGDON.
37. FRANK BAKER, 1888.
38. W. M. BEAUCHAMP, 1889.
39. JOSEPH JASTROW, 1890.
40. W. H. HOLMES, 1891.
41. W. M. BEAUCHAMP, 1892, in place of S. CULIN, resigned.
42. W. K. MOOREHEAD, 1893.
43. A. F. CHAMBERLIN, 1894.
44. { STEWART CULIN and W. W. TOOKER, 1895, in place of ANITA N. MCGEE, res'd.
45. G. H. PERKINS, 1896, in place of J. G. BOURKE,* dec'd.
46. ANITA N. MCGEE, 1897, in place of HARLAN I. SMITH, res'd.
47. MARSHALL H. SAVILLE, 1898.
48. E. W. SCRIPTURE, 1899, in place of GEO. A. DORSEY, resigned.
49. FRANK RUSSELL,* 1900.
50. G. G. MACCURDY, 1901.
51. HARLAN I. SMITH, 1902.
52. R. B. DIXON, 1903.
53–57. GEO. H. PEPPER, 04–08.

Section I.—Social and Economic Science.

31. { FRANKLIN B. HOUGH,* 1882. J. RICHARDS DODGE, 1882.
32. JOSEPH CUMMINGS,* 1883.
33. CHARLES W. SMILEY, 1884.
34. CHAS. W. SMILEY, 1885, in the absence of J. W. CHICKERING.
35. H. E. ALVORD,* 1886.
36. W. R. LAZENBY, 1887.
37. CHARLES S. HILL, 1888.
38. J. RICHARDS DODGE, 1889.
39. B. E. FERNOW, 1890.
40. B. E. FERNOW, 1891.
41. HENRY FARQUHAR, 1892, in place of L. F. WARD, made Vice-President.

SECRETARIES OF THE SECTIONS, CONTINUED.

42. NELLIE S. KEDZIE, 1893.
43. MANLEY MILES, 1894.
44. W. R. LAZENBY, 1895, in place of E. A. Ross, resigned.
45. R. T. COLBURN, 1896.
46. ARCHIBALD BLUE, 1897.
47. MARCUS BENJAMIN, 1898.
48. CALVIN M. WOODWARD, 1899.
49. H. T. NEWCOMB, 1900.
50. R. A. PEARSON, 1901, in place of CORA A. BENNESON, res'd.
51. F. R. RUTTER, 1902, in place of Walter F. Willcox, resigned.
52. F. H. HITCHCOCK, 1903.
53–57. J. F. CROWELL, 1904–08.

Section K.—Physiology and Experimental Medicine.

51. F. S. LEE, 1902.
52. F. S. LEE, 1903.
53. F. S. LEE, 1904.
54–57. W. J. GIES, 1905–08.

TREASURERS.

1. JEFFRIES WYMAN,* 1848.
2. A. L. ELWYN,* 1849.
3. ST. J. RAVENEL,* 1850, in the absence of A. L. ELWYN.*
4. A. L. ELWYN,* 1850.
5. SPENCER F. BAIRD,* 1851, in the absence of A. L. ELWYN.*
6–7. A. L. ELWYN,* 1851–53.
8. J. L. LECONTE,* 1854, in the absence of A. L. ELWYN.*
9–19. A. L. ELWYN,* 1855–1870.
20–30. WM. S. VAUX,* 1871–1881.
32–42. WM. LILLY,* 1882–93.
43–49. R. S. WOODWARD, 1894–1900.
50–54. R. S. WOODWARD, 1901–1905.
55–59. R. S. WOODWARD, 1906–1910.

Commonwealth of Massachusetts.

In the Year One Thousand Eight Hundred and Seventy-Four.

AN ACT

TO INCORPORATE THE "AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE."

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

SECTION 1. Joseph Henry of Washington, Benjamin Pierce of Cambridge, James D. Dana of New Haven, James Hall of Albany, Alexis Caswell of Providence, Stephen Alexander of Princeton, Isaac Lea of Philadelphia, F. A. P. Barnard of New York, John S. Newberry of Cleveland, B. A. Gould of Cambridge, T. Sterry Hunt of Boston, Asa Gray of Cambridge, J. Lawrence Smith of Louisville, Joseph Lovering of Cambridge, and John LeConte of Philadelphia, their associates, the officers and members of the Association, known as the "American Association for the Advancement of Science," and their successors, are hereby made a corporation by the name of the "American Association for the Advancement of Science," for the purpose of receiving, purchasing, holding, and conveying real and personal property, which it now is, or hereafter may be, possessed of, with all the powers and privileges, and subject to the restrictions, duties and liabilities set forth in the general laws which now or hereafter may be in force and applicable to such corporations.

SECTION 2. Said corporation may have and hold by purchase, grant, gift, or otherwise, real estate not exceeding one hundred thousand dollars in value, and personal estate of the value of two hundred and fifty thousand dollars.

SECTION 3. Any two of the corporators above named are hereby authorized to call the first meeting of the said corporation in the month of August next ensuing, by notice thereof "by mail," to each member of the said Association.

SECTION 4. This act shall take effect upon its passage.

HOUSE OF REPRESENTATIVES, March 10, 1874.
Passed to be enacted,
JOHN E. SANFORD, *Speaker.*

IN SENATE, March 17, 1874.
Passed to be enacted,
GEO. B. LORING, *President.*

March 19, 1874.
Approved.
W. B. WASHBURN.

SECRETARY'S DEPARTMENT,
Boston, April 3, 1874.
A true copy, Attest:
DAVID PULSIFER,
Deputy Secretary of the Commonwealth.

CONSTITUTION

OF THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Incorporated by Act of the General Court of the Commonwealth of Massachusetts.

OBJECTS.

ARTICLE 1. The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness.

MEMBERSHIP.

ART. 2. The Association shall consist of members, fellows, patrons, corresponding members and honorary fellows.

MEMBERS.

ART. 3. Any person may become a member of the Association upon recommendation in writing by two members or fellows, and election by the Council. Any incorporated scientific society or institution, or any public or incorporated library, may be enrolled as a member of the Association by vote of the Council by payment of the initiation fee; such society, institution, or library may be represented by either the President, Curator, Director, or Librarian presenting proper credentials at any meeting of the Association for which the assessment has been paid.

ASSOCIATES.

Associates for any single meeting shall be admitted on the payment of three dollars, such associates to have all the privileges of the meeting, except reading papers and voting.

Members of scientific societies whose meetings are contemporaneous with, or immediately subsequent to, that of the Associa-

tion, and which are recognized by vote of the Council as "Affiliated Societies," may become associate members for that meeting on the payment of three dollars. They shall be entitled to all the privileges of membership except voting or appointment to office but their names shall not appear in the list of members printed in the annual report.

FOREIGN ASSOCIATES.

Any member or fellow of any national scientific or educational institution, or of any society or academy of science, of any country not in America, who may be present at any meeting of the Association shall, on presenting the proper credentials, be enrolled without fee as a Foreign Associate, and shall be entitled to all the privileges of the meeting except voting on matters of business.

FELLOWS.

ART. 4. Fellows shall be elected by the Council from such of the members as are professionally engaged in science, or have, by their labors, aided in advancing science. The election of fellows shall be by ballot, and a majority vote of the members of the Council at a designated meeting of the Council.

PATRONS.

ART. 5. Any person paying to the Association the sum of one thousand dollars shall be classed as a patron, and shall be entitled to all the privileges of a member and to all its publications.

HONORARY FELLOWS AND CORRESPONDING MEMBERS.

ART. 6. Honorary fellows of the Association, not exceeding three for each Section, may be elected, the nominations to be made by the Council and approved by ballot in the respective sections before election by ballot in General Session. Honorary fellows shall be entitled to all the privileges of fellows, and shall be exempt from all fees and assessments, and entitled to all publications of the Association issued after the date of their election. Corresponding members shall consist of such scientists not residing in America as may be elected by the Council, and their number shall be limited to fifty. Corresponding members shall be entitled to

all the privileges of members and to the annual volumes of Proceedings published subsequent to their election.

SUSPENSIONS.

ART. 7. The name of any member or fellow two years in arrears for annual dues shall be erased from the list of the Association, provided, that two notices of indebtedness, at an interval of at least three months, shall have been given; and no such person shall be restored until he has paid his arrearages or has been re-elected. The Council shall have power to exclude from the Association any member or fellow, on satisfactory evidence that said member or fellow is an improper person to be connected with the Association, or has in the estimation of the Council made improper use of his membership or fellowship.

OFFICERS.

ART. 8. No member or fellow shall take part in the organization of, or hold office in, more than one section at any one meeting.

ART. 9. The officers of the Association shall be elected by ballot by the General Committee from the fellows, and shall consist of a President, a Vice-President from each section, a Permanent Secretary, a General Secretary, a Secretary of the Council, a Treasurer, and a Secretary of each Section; these, with the exception of the Permanent Secretary, the Treasurer, and the Secretaries of the Sections, shall be elected at each meeting for the following one, and, with the exception of the Treasurer and the Permanent Secretary, shall not be re-eligible for the next two meetings. The term of office of the Permanent Secretary, of the Treasurer, and of the Secretaries of the Sections, shall be five years.

PRESIDENT.

ART. 10. The President, or, in his absence, the senior Vice-President present, shall preside at all General Sessions of the Association and at all meetings of the Council. It shall also be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided.

VICE-PRESIDENTS.

ART. 11. The Vice-Presidents shall be chairmen of their respective Sections, and of their Sectional Committees, and it

shall be part of their duty to give an address, each before his own Section, at such time as the Council shall determine at the meeting subsequent to that at which he presides. The Vice-Presidents may appoint temporary chairmen to preside over the sessions of their sections, but shall not delegate their other duties. The Vice-Presidents shall have seniority in order of their continuous membership in the Association.

GENERAL SECRETARY.

ART. 12. The General Secretary shall be the Secretary of all General Sessions of the Association, and shall keep a record of the business of these sessions. He shall receive the records from the Secretaries of the Sections, which, after examination, he shall transmit with his own records to the Permanent Secretary within two weeks after the adjournment of the meeting.

SECRETARY OF THE COUNCIL.

ART. 13. The Secretary of the Council shall keep the records of the Council. He shall give to the Secretary of each Section the titles of papers assigned to it by the Council. He shall receive proposals for membership and bring them before the Council.

PERMANENT SECRETARY.

ART. 14. The Permanent Secretary shall be the executive officer of the Association under the direction of the Council. He shall attend to all business not specially referred to committees nor otherwise constitutionally provided for. He shall keep an account of all business that he has transacted for the Association, and make annually a general report for publication in the annual volume of Proceedings. He shall attend to the printing and distribution of the annual volume of Proceedings, and all other printing ordered by the Association. He shall issue a circular of information to members and fellows at least three months before each meeting, and shall, in connection with the Local Committee, make all necessary arrangements for the meetings of the Association. He shall provide the Secretaries of the Association with such books and stationery as may be required for their records and business, and shall provide members and fellows with such blank forms as may be required for facilitating the business of the Association. He shall collect all assessments

and admission fees, and notify members and fellows of their election, and of any arrearages. He shall receive, and bring before the Council, the titles and abstracts of papers proposed to be read before the Association. He shall keep an account of all receipts and expenditures of the Association, and report the same annually at the first meeting of the Council, and shall pay over to the Treasurer such unexpended funds as the Council may direct. He shall receive and hold in trust for the Association all books, pamphlets, and manuscripts belonging to the Association, and allow the use of the same under the provisions of the Constitution and the orders of the Council. He shall receive all communications addressed to the Association during the intervals between meetings, and properly attend to the same. He shall at each meeting report the names of fellows and members who have died since the preceding meeting. He shall be allowed a salary which shall be determined by the Council, and may employ one or more clerks at such compensation as may be agreed upon by the Council.

TREASURER.

ART. 15. The Treasurer shall invest the funds received by him in such securities as may be directed by the Council. He shall annually present to the Council an account of the funds in his charge. No expenditure of the principal in the hands of the Treasurer shall be made without a unanimous vote of the Council, and no expenditure of the income received by the Treasurer shall be made without a two-thirds vote of the Council. The Treasurer shall give bonds for the faithful performance of his duty in such manner and sum as the Council shall from time to time direct.

SECRETARIES OF THE SECTIONS.

ART. 16. The Secretaries of the Sections shall keep the records of their respective Sections, and, at the close of the meeting, give the same, including the records of subsections, to the General Secretary. They shall also be the Secretaries of the sectional committees. The Secretaries shall have seniority in order of their continuous membership in the Association.

VACANCIES.

ART. 17. In case of a vacancy in the office of President, the senior Vice-President shall preside, as provided in Article 10

until the General Committee can be assembled and the vacancy filled by election. Vacancies in the offices of Vice-President, Permanent Secretary, Secretary of the Council, Secretaries of the Sections, and Treasurer, shall be filled by the Council by ballot.

COUNCIL.

ART. 18. The Council shall consist of the Past Presidents, and the Vice-Presidents of the last two meetings, together with the President, the Vice-Presidents, the Permanent Secretary, the General Secretary, the Secretary of the Council, the Secretaries of the Sections, and the Treasurer of the current meeting, of one fellow elected from each Section by ballot on the first day of its meeting, of one fellow elected by each affiliated society, and one additional fellow from each affiliated society having more than twenty-five members who are fellows of the Association, and of nine fellows elected by the Council, three being annually elected for a term of three years. The members present at any regularly called meeting of the Council, provided there are at least five, shall form a quorum for the transaction of business. The Council shall meet on the day preceding each annual meeting of the Association, and arrange the program for the first day of the sessions. The time and place of this first meeting shall be designated by the Permanent Secretary. Unless otherwise agreed upon, regular meetings of the Council shall be held in the Council room at 9 o'clock A. M., on each day of the meeting of the Association. Special meetings of the Council may be called at any time by the President. The Council shall be the board of supervision of the Association, and no business shall be transacted by the Association that has not first been referred to, or originated with, the Council. The Council shall decide which papers, discussions, and other proceedings shall be published, and have the general direction of the publications of the Association; manage the financial affairs of the Association; arrange the business and programs for General Sessions; suggest subjects for discussion, investigation or reports; elect members and fellows; and receive and act upon all invitations extended to the Association and report the same at a General Session of the Association. The Council shall receive all reports of Special Committees and decide upon them, and only such shall be read in General

Session as the Council shall direct. The Council shall appoint at each meeting the following subcommittees who shall act, subject to appeal to the whole Council, until their successors are appointed at the following meeting: 1, on Papers and Reports; 2, on Members; 3, on Fellows.

GENERAL COMMITTEE.

ART. 19. The General Committee shall consist of the Council and one member or fellow elected by each of the Sections, who shall serve until their successors are elected. It shall be the duty of the committee to meet at the call of the President and elect the general officers for the following meeting of the Association. It shall also be the duty of this committee to fix the time and place for the next meeting. The Vice-President and Secretary of each Section shall be recommended to the General Committee by the Sectional Committee.

MEETINGS.

ART. 20. The Association shall hold a public meeting annually for one week or longer, at such time and place as may be determined by vote of the General Committee, and the preliminary arrangements for each meeting shall be made by the Local Committee, in conjunction with the Permanent Secretary and such other persons as the Council may designate.

But if suitable preliminary arrangements cannot be made, the Council may afterward change the time and place appointed by the General Committee, if such change is believed advisable, by two-thirds of the members present.

ART. 21. A General Session shall be held at 10 o'clock, A. M. on the first day of the meeting, and at such other times as the Council may direct.

SECTIONS AND SUBSECTIONS.

ART. 22. The Association shall be divided into Sections, namely:—A, *Mathematics and Astronomy;* B, *Physics;* C, *Chemistry; including its application to Agriculture and the Arts;* D, *Mechanical Science and Engineering;* E, *Geology and Geography;* F, *Zoology;* G, *Botany;* H, *Anthropology;* I, *Social and Economic Science;* K, *Physiology and Experimental Medicine.* The Council shall have

power to consolidate any two or more Sections temporarily, and such consolidated Sections shall be presided over by the senior Vice-President and Secretary of the Sections comprising it.

SECTIONAL COMMITTEES.

ART. 23. Immediately on the organization of a Section there shall be a member or fellow elected by ballot after open nomination, who, with the Vice-President and Secretary and the Vice-President and Secretary of the preceding meeting, and the members or fellows elected by ballot at the four preceding meetings, shall form its Sectional Committee. The Sectional Committees shall have power to fill vacancies in their own numbers. Meetings of the Sections shall not be held at the same time with a General Session. The Sectional Committee may invite distinguished foreign associates present at any meeting to serve as honorary members of said Committee.

ART. 24. The Sectional Committee of any Section may at its pleasure form one or more temporary Subsections, and may designate the officers thereof. The Secretary of a Subsection shall at the close of the meeting, transmit his records to the Secretary of the Section.

ART. 25. No paper shall be read in any Section or Subsections until it has been placed on the program of the day by the Sectional Committee.

ART. 26. The Sectional Committees shall arrange and direct the business of their respective Sections. They shall prepare the daily programs and give them to the Permanent Secretary for printing at the earliest moment practicable. No titles of papers shall be entered on the daily programs except such as have passed the Committee. No change shall be made in the program for the day in a Section without the consent of the Sectional Committee. The Sectional Committees may refuse to place the title of any paper on the program; but every such title, with the abstract of the paper or the paper itself, must be referred to the Council with the reasons why it was refused. The Sectional Committee shall also make nominations to the General Committee for Vice-President and Secretary of their respective Sections as provided for in Article 19.

ART. 27. The Sectional Committees shall examine all papers and abstracts referred to the Sections, and they shall not place

on the program any paper inconsistent with the character of the Association; and to this end they have power to call for any paper, the character of which may not be sufficiently understood from the abstract submitted.

PAPERS AND COMMUNICATIONS.

ART. 28. All members and fellows must forward to the Secretary of the proper Section or to the Permanent Secretary, as early as possible, and when practicable before the convening of the Association, full titles of all the papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery, and also such abstracts of their contents as will give a general idea of their nature; and no title shall be considered by a Sectional Committee until an abstract of the paper or the paper itself has been received.

ART. 29. If the author of any paper be not ready when called upon, in the regular order of the official program, the title may be dropped to the bottom of the list.

ART. 30. Whenever practicable the proceedings and discussions at General Sessions, Sections and Subsections, shall be reported by professional reporters, but such reports shall not appear in print as the official reports of the Association unless revised by the Secretaries.

PRINTED PROCEEDINGS.

ART. 31. The Permanent Secretary shall have the Proceedings of each meeting printed in an octavo volume as soon after the meeting as possible, beginning one month after adjournment. Authors must prepare their papers or abstracts ready for the press, and these must be in the hands of the Secretaries of the Sections before the final adjournment of the meeting, otherwise only the titles will appear in the printed volume. The Council shall have power to order the printing of any paper by abstract or title only. Whenever practicable, proofs shall be forwarded to authors for revision. If any additions or substantial alterations are made by the author of a paper after its submission to the Secretary, the same shall be distinctly indicated. Illustrations must be provided for by the authors of the papers, or by a special appropriation from the Council. Immediately on publication of

the volume, a copy shall be forwarded to every member and fellow of the Association who shall have paid the assessment for the meeting to which it relates, and it shall also be offered for sale by the Permanent Secretary at such price as may be determined by the Council. The Council shall also designate the institutions to which copies shall be distributed.

LOCAL COMMITTEE.

ART. 32. The Local Committee shall consist of persons interested in the objects of the Association and residing at or near the place of the proposed meeting. It is expected that the Local Committee, assisted by the officers of the Association, will make all essential arrangements for the meeting, and issue a circular giving necessary particulars, at least one month before the meeting.

LIBRARY OF THE ASSOCIATION.

ART. 33. All books and pamphlets received by the Association shall be in charge of the Permanent Secretary, who shall have a list of the same printed and shall furnish a copy to any member or fellow on application. Members and fellows who have paid their assessments in full shall be allowed to call for books and pamphlets, which shall be delivered to them at their expense on their giving a receipt agreeing to make good any loss or damage, and to return the same free of expense to the Secretary at the time specified in the receipt given. All books and pamphlets in circulation must be returned at each meeting. Not more than five books, including volumes, parts of volumes, and pamphlets shall be held at one time by any member or fellow. Any book may be withheld from circulation by order of the Council. [The Library of the Association was, by vote of the Council in 1895, placed on deposit in the Library of the University of Cincinnati, Ohio. Members can obtain the use of books by writing to the Librarian of the University Library, Cincinnati, Ohio.]

ADMISSION FEE AND ASSESSMENTS.

ART. 34. The admission fee for members shall be five dollars in addition to the annual dues.

ART. 35. The annual dues for members and fellows shall be three dollars.

ART. 36. Any member or fellow who shall pay the sum of fifty dollars to the Association, at any one time, shall become a Life Member, and as such shall be exempt from all further assessments, and shall be entitled to the Proceedings of the Association. All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the Association but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the Council.

ART. 37. All fees and dues must be paid to the Permanent Secretary, who shall give proper receipts for the same.

ACCOUNTS.

ART. 38. The accounts of the Permanent Secretary and of the Treasurer shall be audited annually by Auditors appointed by the Council.

ALTERATIONS OF THE CONSTITUTION.

ART. 39. No part of this Constitution shall be amended or annulled, without the concurrence of three-fourths of the members and fellows present in General Session, after notice given at a General Session of a preceding meeting of the Association.

MEMBERS AND FELLOWS

OF THE

AMERICAN ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE.

SURVIVING FOUNDERS.

[At the Brooklyn Meeting, 1894, a resolution was unanimously adopted by which all the surviving founders of the Association who have maintained an interest in science were made Honorary Life Members of the Association in recognition of their pioneer work in American Science.]

BOYÉ, MARTIN H., Coopersburg, Pa.
GIBBS, WOLCOTT, Newport, R. I.

PATRONS.

[Persons contributing one thousand dollars or more to the Association are classed as Patrons, and are entitled to the privileges of members and to the publications. The names of Patrons are to remain permanently on the list.]

THOMPSON, MRS. ELIZABETH, Stamford, Conn. (22). (Died July, 1899.)
LILLY, GEN. WILLIAM, Mauch Chunk, Pa. (28). (Died Dec. 1, 1893.)
HERRMAN, MRS. ESTHER, 59 West 56th St., New York, N. Y. (29).
MCMILLIN, EMERSON, 40 Wall St., New York, N. Y. (37).

HONORARY FELLOWS.

[See ARTICLE VI of the Constitution.]

*GIBBS, PROF. WOLCOTT, Newport, R. I. (1). 1896. **B C**
*WARINGTON, ROBERT, F. R. S., Rothamsted, Harpenden, England. (40). 1899. **C**
*WESTINGHOUSE, GEORGE, Pittsburg, Pa. (50). 1902. **D**

MEMBERS AND FELLOWS.

The names designated by an asterisk (*) are those of Fellows. (See ARTICLE IV of the Constitution.) The number in parenthesis indicates the meeting at which the Member joined the Association; the date following is the year when made a Fellow; the black letters at end of line are those of the Sections to which the Member or Fellow belongs. When the name is given in small capitals, it designates that the Member or Fellow is also a Life Member. And Member or Fellow may become a Life Member by the payment of fifty dollars. The income of the money derived from a life membership is used for the general purposes of the Association during the life of the Member; afterwards it is to be used to aid in original research. Life Members are exempt from the annual assessment, and are entitled to the publications. The names of Life Members are printed in small capitals in the regular list of Members and Fellows.

The Constitution requires that the names of all Members two years in arrears shall be omitted from the list, but their names will be restored on payment of arrearages Members not in arrears are entitled to the publications of the Association, including the journal *Science*.

*Abbe, Cleveland, Professor of Meteorology, Weather Bureau, U. S. Dept. Agriculture, Washington, D. C. (16). 1874. **A B**

*Abbe, Cleveland, Jr., U. S. Geological Survey, Washington, D. C. (44). 1899. **E**

*Abbe, Dr. Robert, 13 W. 50th St., New York, N. Y. (36). 1892,

*Abbot, Charles G., Smithsonian Institution, Washington, D. C. (49). 1902. **B**

Abbot, E. Stanley, M. D., First Assistant Physician, McLean Hospital, Waverley, Mass. (54). **K**

*Abbot, Henry L., Brigadier-General, U. S. A., Retired, 23 Berkeley St., Cambridge, Mass. (54). 1906. **B D**

*Abbott, Alexander C., Univ. of Penna., Philadelphia, Pa. (52). 1905. **K**

Abbott, Frank L., Professor of Physical Science, State Normal School, Greeley, Colo. (50). **B E**

Abbott, Theodore Sperry, C. E., Saltillo, Coahuila, Mexico. (52). **D**

*Abel, John J., Professor of Pharmacology, Johns Hopkins University, Baltimore, Md. (51). 1902. **C**

Abraham, Abraham, care of Abraham & Straus, Brooklyn, N. Y. (43).

Abrams, LeRoy, National Museum, Washington, D. C. (54). **G**

*Acheson, Edward Goodrich, President of the International Acheson Graphite Co., Niagara Falls, N. Y. (50). 1903. **C**

*Adams, Charles C., University of Michigan, Ann Arbor, Mich. (50). 1903. **F**

*Adams, Charles Francis, Head of Science Department, Central High School, Detroit, Mich. (53). 1906. **B**

Adams, Comfort A., 13 Farrar St., Cambridge, Mass. (47). **B**

*Adams, Cyrus C., 416 W. 118th St., New York, N. Y. (54). 1906. **E**

Adams, C. F., Entomologist, Univ. Arkansas, Fayetteville, Ark (54). **F**

Adams, Edward Dean, 1414–15 Empire Bldg., New York, N. Y. (49).

Adams, Frederick C., Mechanic Arts High School, Boston, Mass. (50). **B C**

Adams, John W., Prof. of Physics, McKinley Manual Training School, Washington, D. C. (54). **B G**

Adams, Orr J., Telluride, Colo. (53). **C**

Adams, Matthew Prior, Instructor in Physics and Chemistry, State Normal School, New Britain, Conn. (54). **B C**

*Adler, Cyrus, Smithsonian Institution, Washington, D. C. (54). 1906. **H**

*Adler, Felix, M. D., 123 E. 60th St., New York, N. Y. (54). 1906. **K**

*Adler, Isaac, M. D., 22 E. 62d St., New York, N. Y. (49). 1903. **K**

*Adriance, John S., 105 E. 39th St., New York, N. Y. (39). 1895. **C**

Agnew, P. G., Bureau of Standards, Washington, D. C. (54). **B**

*Aguilera, José G., Director of the Geological Institute of Mexico. Mexico City, Mexico. (53). 1905. **E**

Aikin, Joseph M., M. D., Professor of Mental Diseases, Univ. of Nebraska College of Medicine, Omaha, Neb. (55). **K**

Ailes, Hon. Milton E., Riggs National Bank, Washington, D. C. (52). **I**

Ainsworth, Herman Reeve, M. D., Addison, N. Y. (51). **I K**

*Aitken, Robert G., Lick Observatory, Mt. Hamilton, Cal. (53). 1906. **A**

Akeley, Lewis E., Professor of Physics and Chemistry, University of South Dakota, Vermillion, S. Dak. (51). **B C**

Albert, Harry Lee, Professor of Biology, State Normal School, Cape Girardeau, Mo. (53). **F G**

Albrecht, Emil Poole, Secretary of The Bourse, 1523 N. 17th St., Philadelphia, Pa. (51). **A D**

*Albrecht, Sebastian, Lick Observatory, Mt. Hamilton, Cal. (53). 1906. **A**

Albree, Chester B., Mechanical Engineer, 1115 Market St., Allegheny, Pa. (50). **D**

*Alden, John, Pacific Mills, Lawrence, Mass. (36). 1898.

*Alderson, Victor C., President Colorado School of Mines, Golden, Colorado. (50). 1903. **D**

*Aldrich, Truman Heminway, 1739 P St. N.W., Washington, D. C. (54). 1906. **E**

*Aldrich, Wm. S., Director, Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y. (43). 1897. **D**

Alexander, Curtis, Mining Engineer, Cedral, San Luis Potosi, Mexico. (50). **E**

Alexander, Harry, E. E., M. E., 18 and 20 W. 34th St., New York, N. Y. (50). **D**

*Aley, Robert J., Ph. D., Indiana Univ., Bloomington, Ind. (49). 1906. A

Allabach, Miss Lulu F., Instructor in Biology and Zoology Central State Normal School, Lock Haven, Pa. (52). F

Allderdice, Wm. H., Commander U. S. Navy, Navy Dept., Washington, D. C. (33). D

Alleman, Gellert, Ph. D., Swarthmore College, Swarthmore, Pa. (50). C

*Allen, Bennet Mills, Instructor in Anatomy, University of Wisconsin. Madison, Wis. (54). 1906. F K

Allen, Charles Elmer, 810 W. Johnson St., Madison, Wis. (55). G

Allen, Charles Metcalf, Assistant Prof. of Experimental Engineering, Worcester Polytechnic Institute, Worcester, Mass. (52). D

Allen, Edwin West, Editor of *Experiment Station Record*, U. S. Dept. Agriculture, Washington, D. C. (52). I

*Allen, Frank, Ph. D., Professor of Physics, Univ. of Manitoba, Winnipeg, Manitoba. (49). 1903. B

Allen, Hon. F. I., Commissioner of Patents, Washington, D. C. (52). I

*Allen, Glover Morrill, Secretary Boston Soc. Nat. Hist., 16 Oxford St., Cambridge, Mass. (52). 1903. F

Allen, H. Jerome, M. D., 421 H St., N.E., Washington, D. C. (51). K

Allen, Lyman Richards, Instructor in Geography and History, State Normal School, North Adams, Mass. (54). E

Allen, Richard H., Chatham, N. J. (49).

*Allis, Edward Phelps, Jr., Palais Carnolès, Menton, France. (52). 1905. F

*Allison, Andrew, Ellisville, Miss. (54). 1906. F G

*Allison, C. Edward, M. D., Elysburg, Pa. (51). 1906. K

Allison, Hendery, M. D., 260 West 57th St., New York, N.Y. (50). K

Allison, William B., 1320 St. Charles Ave., New Orleans, La. (55). G

Almond, Thomas R., M. E., 83–85 Washington St., Brooklyn, N. Y. (51). D

*Almy, John E., Ph. D., Instructor in Physics, University of Nebraska, Lincoln, Neb. (50). 1901. B

Alsberg, Carl Lucas, Dept. Biological Chemistry, Harvard Medical School, Boston, Mass. (55). C

Alsop, E. B., 1502 20th St., N. W., Washington, D. C. (50). D

Alspach, E. F., 455 West Sixth Ave., Columbus, O. (48). H

Altamirano, Dr. Fernando, Instituto Medico Nacional, Esquina de Balderas y Ayuntamiento num 1202, Mexico, D. F. (53). G

Alwine, John, Jr., Associate Manager Baltimore Chrome Works, 1348 Block St., Baltimore, Md. (54). C

*Alwood, Wm. B., Charlottesville, Va. (39). 1891. F

*Ames, Oakes, Assistant Director of the Botanic Garden of Harvard University, North Easton, Mass. (50). 1905. G

*Ami, H. M., Geological Survey of Canada, Ottawa, Ontario, Canada, (54). 1906. E

Amweg, Frederick James, Engineer and Manager, American, Hawaiian Engineering and Construction Co., Ltd., 218–222 Rialto Building, San Francisco, Cal. (51). D

Anders, Howard S., M. D., 1836 Wallace St., Philadelphia, Pa. (51). K

Anderson, A. J. C., 127 Water St., New York, N. Y. (49).

*Anderson, Alexander P., American Cereal Co., Railway Exchange Building, Chicago, Ill. (45). 1899. G

Anderson, Prof. Douglas S., Tulane Univ., New Orleans, La. (49). B D

*Anderson, Frank E. M., 255 Second East St., Salt Lake City, Utah. (50). 1906. D E

Anderson, Frank P., Epworth, Iowa. (46).

Anderson, J. Hartley, M. D., 4630 Fifth Ave., Pittsburg, Pa. (50). K

*Anderson, William G., M. D., Director Yale University Gymnasium, New Haven, Conn. (52). 1906. H K

Anderson, Winslow, M. D., President of College of Physicians and Surgeons of San Francisco, 1025 Sutter St., San Francisco, Cal. (51). K

Andrews, Clement Walker, Librarian of The John Crerar Library, Chicago, Ill. (53). C

*Andrews, Frank Marion, Ph. D., Asst. Professor Botany, Indiana University, Bloomington, Ind. (52). 1903. G

Andrews, Wm. Edward, Principal Township High School, Taylorville, Ill. (52). D

Andrews, William Symes, care Gen'l Elec. Co., Schenectady, N. Y. (50). D E

Angle, Dr. Edward H., 1023 North Grand Ave., St. Louis, Mo. (53). F

Annear, John Brothers, 1028 Regent St., Boulder, Colo. (50). C.

Anthony, Richard A., 122–124 Fifth Ave., New York, N. Y. (49).

*Anthony, Prof. Wm. A., Cooper Union, New York, N. Y. (28). 1880. B

Apple, Joseph H., President of the Woman's College, Frederick, Md. (52). I

*Appleton, John Howard, Sc. D., Professor of Chemistry, Brown University, Providence, R. I. (50). 1901. C

Archer, George Frost, 31 Burling Slip, New York, N. Y. (50). D

*Archibald, Raymond Clare, Sackville, New Brunswick, Canada. (54) 1906. **A**

*Argall, Philip, Mining and Metallurgical Engineer, 730 Majestic Building, Denver, Col. (54). 1906. **C E**

Armfield, Frank, Attorney at Law, Monroe, N. C. (55). **I**

Armitage, Thomas L., M. D., Princeton, Minnesota. (51). **K**

*Armsby, Henry Prentiss, Director Agrl. Expr. Station, State College, Centre Co., Pa. (52). 1903. **C**

*Arnold, Bion Joseph, 4128 Prairie Ave., Chicago, Ill. (50). 1903. **D**

Arnold, Delos, 70 S. Orange Grove Boulvd, Pasadena, Cal. (51).

Arnold, Ernst Hermann, M. D., Director New Haven Normal School of Gymnastics, 46 York Square, New Haven, Conn. (52). **K**

*Arnold, Ralph, U. S. Geological Survey, Washington, D. C. (51). 1906. **E**

*Arthur, J. C., D. Sc., Botanist Agric. Exper. Sta., Purdue Univ. Lafayette, Ind. (21). 1883. **G**

Ascham, Louis, 420 W. Willow St., Chippewa Falls, Wis. (54). **F G**

Asdale, William James, M. D., Professor of Gynecology, Western Penna. Medical College, Pittsburg, Pa. (51). **K**

Ashbrook, Donald Sinclair, 905 Del. Ave., Wilmington, Del. (51). **C**

*Ashley, George Hall, U. S. Geol. Survey, Washington, D. C. (51). 1903. **E F**

*Ashmead, Wm. H., Department of Insects, U. S. National Museum, Washington, D. C. (40). 1892. **F**

*Ashton, Charles Hamilton, Assistant Professor of Mathematics, University of Kansas, Lawrence, Kansas. (53). 1906. **A**

Aspinwall, John, 290 Broadway, New York, N. Y. (49).

Atkins, Prof. Martin D., 269 Forest Ave., River Forest, Ill. (48). **B**

*Atkinson, Edward, 31 Milk St., Boston, Mass. (29). 1881. **D I**

*Atkinson, George F., Cornell University, Ithaca, N. Y. (39) 1892. **G**

Atkinson, John B., Earlington, Ky. (26). **D**

*Atwell, Charles B., Northwestern Univ., Evanston, Ill. (36). 1890. **G**

*Auchincloss, Wm. S., Atlantic Highlands, N. J. (29). 1886. **A D**

*Austen, Prof. Peter T., 80 Broad St., New York, N. Y. (44). 1896. **C**

Austin, C. F., Horticulturist, Estacion Central Agronomica, Santiago de las Vegas, Cuba. (54). **G**

Austin, Oscar P., Chief of Bureau of Statistics, Dept. of Commerce and Labor, Washington, D. C. (51). **I**

*Avery, Elroy M., Ph. D., LL.D., 657 Woodland Hills Ave. Cleveland, Ohio. (37). 1889. **B**

Ayer, Edward Everett, Railway Exchange Bldg., Chicago, Ill. (37). H

Ayer, James I., 5 Main St. Park, Malden, Mass. (50). D

*Ayers, Howard, President Univ. of Cincinnati, Cincinnati, Ohio. (49). 1901. F

*Ayres, Dr. Brown, President of University of Tennessee, Knoxville, Tenn. (31). 1885. B

Ayres, Horace B., Aitkin, Minn. (40).

Babbitt, James A., M. D., Assoc. Prof. Physiology, Haverford College, Haverford, Pa. (54). K

Babcock, Charles A., Supt. Schools, Oil City, Pa. (52). F

*Babcock, Prof. S. Moulton, 432 Lake St., Madison, Wis. (33). 1885. C

Babcock, W. Wayne, M. D., 3302 No. Broad St., Philadelphia, Pa. (54). K

*Baber Zonia, Instructor in Geography, University of Chicago, Chicago, Ill. (54). 1906. E

Bacon, Arthur Avery, Professor of Physics, Hobart College, Geneva, N. Y. (53). B

Baerecke, John F., M. D., Professor of Biology, Stetson University, DeLand, Fla. (50). F K

Bagby, J. H. C., Dept. Physical Science, Hampden-Sidney College, Hampden-Sidney, Va. (50). B

*Bagg, Rufus Mather, Jr., Ph. D., High School, Brockton, Mass. (49). 1903. E

BAGGALEY, RALPH, Pittsburg, Pa. (50). D

*Bailey, E. H. S., Professor of Chemistry, Univ. of Kansas, Lawrence, Kan. (25). 1889. C E

Bailey, E. P., In charge Department of Geology and Geography, Brockton High School, Brockton, Mass. (52). E

Bailey, Frank H., Com'dr, U. S. N., 15 Halsey St., Brooklyn, N. Y. (52). D

*Bailey, Solon Irving, Associate Prof. Astronomy, Harvard Observatory, Cambridge, Mass. (50). 1901. A

*Bailey, Vernon, Department of Agriculture, Washington, D. C. (52). 1904. F

*Bain, Samuel M., Professor of Botany, University of Tennessee, Knoxville, Tenn. (50). 1902. G

*Bair, Joseph Hershey, Ph. D., Professor of Psychology, University of Colorado, Boulder, Colo. (52). 1905. H K

*Baird, John Wallace, Johns Hopkins Univ., Baltimore, Md. (53). 1905. H

*Baird, Lucy H., 1703 Rittenhouse St., Philadelphia, Pa. (54) 1906. I

Baird, Robert Logan, Principal, Denmark Academy, Denmark, Iowa. (53). F

Baker, A. G., Springfield, Mass. (44).
*Baker, Carl F., Botanist, Estacion Central Agronomica Santiago de las Vegas, Cuba. (54). 1906. G
*Baker, Frank, M. D., 1728 Columbia Road, Washington, D. C. (31). 1886. F H K
Baker, Frederic, 815 Fifth Ave., New York, N. Y. (40).
Baker, Hugh P., Asst. Professor Dept. Hort. and Forestry, Iowa State College, Ames, Iowa. (51). G
*Baker, James H., LL. D., President of the University of Colorado, Boulder, Colo. (50). 1903. I
Baker, Robt. H., Assistant in Astronomy, Observatory House, Amherst, Mass. (54). A
Baker, Smith, M. D., Winston Building, Utica, N. Y. (54). K
*Bakewell, Charles Montague, Yale University, New Haven, Conn. (54). 1906. I
Balch, Alfred William, Assistant Surgeon, U. S. N., Naval Museum of Hygiene and Medical School, Washington, D. C. (52). C K
*Balch, Edwin Swift, 1412 Spruce St., Philadelphia, Pa. (51), 1903. E H
Balch, Francis Noyes, Prince St., Jamaica Plain, Mass. (50). F
Baldwin, A. E., M. D., 34–36 Washington St., Chicago, Ill. (54). K
Baldwin, Mrs. G. H., 3 Madison Ave., Detroit, Mich. (34). H
Baldwin, Helen, 53 East 20th St., New York, N. Y. (54). C
Baldwin, Herbert B., 9–11 Franklin St., Newark, N. J. (43).
*Baldwin, Prof. J. Mark, Johns Hopkins Univ., Baltimore, Md. (46). 1898. H
*Baldwin, Hon. Simeon E., Associate Judge of Supreme Court of Errors, New Haven, Conn. (50). 1901. I
*Baldwin, S. Prentiss, 736 Prospect St., Cleveland, Ohio. (47). 1900. E
*Ball, Carleton R., U. S. Dept. Agriculture, Washington, D. C. (49). 1902. G
*Ball, Elmer Darwin, Professor of Zoölogy and Entomology, State Agricultural College, Logan, Utah. (50). 1903. F
Ball, Miss Helen Augusta, 43 Laurel St., Worcester, Mass. (50). F
Ballard, C. A., Curator of Museum, State Normal School, Moorhead, Minn. (51).
*Ballard, Harlan H., 50 South St., Pittsfield, Mass. (31). 1891. E F
*Balliet, Thomas M., New York Univ., Washington Square, New York, N. Y. (48). 1903. H I
Bancroft, Frank Watts, Ph. D., Instructor in Physiology, University of California, Berkeley, Cal. (50). F K
Bancroft, J. Sellers, M. E., 919 Pine St., Philadelphia, Pa. (51). D

*Bancroft, Wilder Dwight, Professor of Chemistry, Cornell University, Ithaca, N. Y. (50). 1901. B C

BANGS, LEMUEL BOLTON, M. D., 39 E. 72d St., New York, N. Y. (36).

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*Banker, Howard J., Prof. Biology, Depauw Univ., Greencastle, Ind. (51). 1905. G

Banks, William C., Electrician, Gordon Battery Co., 439 E. 144th St., New York, N. Y. (50). D

Banta, Arthur M., 12 Sumner St., Cambridge, Mass. (53). F

Barbour, Miss Carrie Adeline, Dept. of Geology, Univ. of Nebraska, Lincoln, Neb. (53). E

*Barbour, Erwin Hinckley, Prof. of Geology, Univ. of Nebraska, Lincoln, Neb. (45). 1898. E

Barbour, Thomas, Agassiz Museum, Cambridge, Mass. (50). F

Barck, Dr. Carl, 2715 Locust St., St. Louis, Mo. (52).

*Bardeen, Charles Russell, Professor of Anatomy, University of Wisconsin, Madison, Wis. (50). 1901. F K

Bardeen, Charles William, 406 So. Franklin St., Syracuse, N.Y. (52).

Barkan, Adolph, M. D., LL.D., James Flood Building, San Francisco, Cal. (51). K

*BARKER, PROF. G. F., 3909 Locust St., Philadelphia, Pa. (13). 1875. B C

Barker, Mrs. Martha M., 42 Eleventh St., Lowell, Mass. (31). E H

Barker, Vincent K., 207½ E. Kennedy St., Syracuse, N. Y. (54). F G

Barlow, John, Professor of Zoölogy, R. I. College of A. and M. Arts, Kingston, R. I. (51). F

*Barnard, Edward E., Yerkes Observatory, Williams Bay, Wis. (26). 1883. A

*Barnes, Charles Reid, Ph. D., Univ. of Chicago, Chicago, Ill. (33). 1885. G

Barnes, Edward W., Box 446, New York, N. Y. (49).

Barnett, Mrs. Lelia Jefferson, Physics Building, Tulane University, New Orleans, La. (52). A

Barnett, Robert Crary, C. E., 510 Kansas City Life Bldg., Kansas City, Mo. (51). D

Barnhart, Arthur M., 185 Monroe St., Chicago, Ill. (42).

*Barnhart, John H., M. D., Tarrytown, N. Y. (49). 1903. G

Barnsley, George Thomas, C. E., Oakmont, Pa. (51). D

*Barnum, Miss Charlotte C., Ph. D., U. S. Coast and Geodetic Survey, Washington, D. C. (36). 1896. A

Barr, Charles Elisha, Professor of Biology, Albion College, Albion, Mich. (50). F

*Barr, John Henry, care of Smith Premier Typewriter Co., Syracuse, N. Y. (51). 1903. **D**

*Barrell, Joseph, Yale University Museum, New Haven, Conn. (51). 1905. **E**

Barrie, Dr. George, 2131 Mass. Ave., N.W., Washington, D. C. (49). **H I**

Barringer, Daniel Moreau, Geologist and Mining Engineer, 460 Bullitt Building, Philadelphia, Pa. (50). **D E**

*Barrows, Walter B., Professor of Zoölogy and Geology, Agricultural College, Mich. (40). 1897. **F**

Bartholomew, C. E., Instructor in Zoölogy, Iowa State College, Ames, Iowa. (54). **F**

*Bartlett, Prof. Edwin J., Dartmouth College, Hanover, N. H. (28). 1883. **C**

*Bartlett, Francis, 40 State St., Boston, Mass. (50). 1906. **I**

Bartlett, George Miller, Instructor in Drawing and Descriptive Geometry, University of Michigan, Ann Arbor, Mich. (52). **B**

*Bartley, Elias H., M. D., 21 Lafayette Ave., Brooklyn, N. Y. (33). 1894. **C**

*Barton, G. E., 419 N. High St., Millville, N. J. (46). 1898. **C**

*Barton, George Hunt, Dept. of Geology, Mass. Inst. Tech., Boston, Mass. (47). 1900. **E**

Barton, Philip Price, E. E., Sup't Niagara Falls Power Co., 127 Buffalo Ave., Niagara Falls, N. Y. (50). **D E**

*Barton, Samuel M., Ph. D., The Univ. of the South, Sewanee, Tenn. (43). 1899. **A**

*Bartow, Edward, Ph. D., University of Illinois Urlana, Ill. (47). 1906. **C**

*Bartsch, Paul, Ph. D., Smithsonian Institution, Washington, D. C. (52). 1906. **F**

*Barus, Carl, Ph. D., Wilson Hall, Brown Univ., Providence, R. I. (33). 1887. **B**

Barwell, John William, Waukegan, Ill. (47).

*Bascom, Miss Florence, Bryn Mawr College, Bryn Mawr, Pa. (42). 1897. **E**

Bashore, Dr. Harvey B., West Fairview, Pa. (46). **E**

*Baskerville, Charles, Professor of Chemistry, College of the City of New York, New York, N. Y. (41). 1894. **C E**

Baskett, James Newton, Mexico, Mo. (50). **F I**

*Basquin, Olin H., Associate Professor of Physics, Northwestern University, Evanston, Ill. (53). 1906. **B D**

Bassett, Carroll Phillips, Ph. D., Civil and Consulting Engineer, Summit, N. J. (51). **D**

Batchelder, Charles Foster, 7 Kirkland St., Cambridge, Mass. (54).

Bates, Henry H., Ph. D., McGill Building, Washington, D. C. (52). **A B D**

*Bates, Rev. John Mallery, Red Cloud, Neb. (51). 1903. **G I**

*Bauer, Louis A., Ph. D., U. S. C. and G. Survey, Washington, D. C. (40). 1892. **A B**

Baumgardt, B. R., 626 W. 30th Street, Los Angeles, Cal. (51). **A**

*Bausch, Edw., P. O. Drawer 1033, Rochester, N. Y. (26). 1883. **A B C F**

Bausch, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).

*Bawden, H. Heath, Professor of Psychology and Philosophy, Vassar College, Poughkeepsie, N. Y. (51). 1905. **F**

*Baxter, Gregory Paul, First National Bank Bldg., Portland, Me. (54). 1906. **C**

Baxter, James Phinney, President, Maine Historical Society, Portland, Maine. (50). **H I**

*Bayley, Wm. Shirley, Lehigh Univ., S. Bethlehem, Pa. (53). 1905. **E**

Beach, Miss Alice M., care G. W. Cutler, Calistoga, Cal. (50). **F**

Beach, Charles Coffing, M. D., 54 Woodland St., Hartford, Conn. (50). **F K**

Beach, Henry Harris Aubrey, M. D., 28 Commonwealth Ave., Boston, Mass. (50). **F K**

*Beach, Spencer Ambrose, Iowa State College, Ames, Iowa. (41). 1900. **G**

Beahan, Willard, 103 Cummington Road, S.E., Cleveland, Ohio. (51). **D**

Beal, James Hartley, Professor of Pharmacy, Scio College of Pharmacy Scio, Ohio. (54). **C**

Beal, Walter Henry, Assistant, Office of Experiment Stations, U. S. Dept. Agriculture, Washington, D. C. (52).

*Beal, Wm. James, Ph. D., Professor of Botany, Agricultural College, Mich. (17). 1880. **G**

Beaman, George Herbert, 2232 Mass. Ave. N.W., Washington, D. C. (52). **I**

*Beardsley, Arthur E., Professor of Biology, Colorado State Normal School, Greeley, Colo. (50). 1901. **F**

Beates, Henry, Jr., M. D., President of State Board of Medical Examiners, 1504 Walnut St., Philadelphia, Pa. (51). **K**

Beattie, J. C., D. Sc., F. R. S. E., South African College, Cape Town, S. Africa. (54). **F**

Beatty, James W. F., Pitcairn, Pa. (51).

Bebb, Edward C., U. S. Geological Survey, Washington, D. C. (52). **E**

*Beck, Carl, M. D., Professor of Surgery, New York, Postgraduate Medical School, President of St. Mark's Hospital, 37 E. 31st St., New York, N. Y. (51). 1906. **K**

Beck, Herbert H., Assistant Professor of Chemistry, Franklin and Marshall College, Y. M. C. A. Building, Lancaster, Pa. (53). **C**

*Becker, Dr. Geo. F., U. S. Geol. Survey, Washington, D. C. (36). 1890. **E**

Beckwith, Miss Florence, Scottsville, N. Y. (45). **G**

*Beckwith, Paul Edmond, U. S. National Museum, Washington, D. C. (54). 1906. **H**

*Bedell, Frederick, Ph. D., Cornell Univ., Ithaca, N. Y. (41). 1894. **A B**

*Beebe, C. William, Curator of Ornithology, N. Y. Zoölogical Park, New York, N. Y. (53). 1905. **F**

*Beebe, Silas Palmer, Physiological Chemist to the Huntington Fund for Cancer Research, 216 Central Ave., Flushing, N. Y. (54). 1906. **K**

*Beede, Joshua William, Indiana University, Bloomington, Ind. (50). 1906. **E**

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Beer, William, Chief Clerk, New Orleans Public Library, New Orleans, La. (54). **H**

*Behrend, Bernhard Arthur, C. E., E. E., Station H, Cincinnati, Ohio. (50). 1903. **D E**

*Bell, Alex. Graham, Ph. D., 1331 Conn. Ave., N.W. Washington, D. C. (26). 1879. **B H I**

*Bell, Albert T., Professor of Botany, Wesleyan Univ., University Place, Neb. (52). 1903. **G**

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*Bell, John Everett, M. E., care of The Stirling Co., Barberton, Ohio. (53). 1906. **D**

*Bell, Robert, M. D., LL.D., F. R. S., Geol. Survey, Ottawa, Can. (38). 1889. **E F**

Bellows, Horace M., M. D., Huntingdon Valley, Pa. (51) **K**

*Belmont, August, 23 Nassau St., New York, N. Y. (50). 1906. **I**

*Beman, Wooster W., Univ. of Michigan, Ann Arbor, Mich. (34). 1886. **A**

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Béndrat, Rev. Thomas Albert, Constableville, N. Y. (52).

Benedict, Francis Gano, Professor of Chemistry, Wesleyan Univ., Middletown, Conn. (55). **C**

Benedict, Harris Miller, Instructor in Biology, University of Cincinnati, 103 West St. Clair St., Cincinnati, Ohio. (52). **F**

*Benjamin, Marcus, U. S. National Museum, Washington, D. C. (27). 1887. **C I**

*Benjamin, Rev. Raphael, M. A., Hotel St. George, Brooklyn, N. Y. (34). 1887. **E F G H**

*Benneson, Miss Cora Agnes, A. M., LL. B., 4 Mason St., Cambridge, Mass. (47). 1899. H I

*Bennett, A. A., Professor of Chemistry, Iowa State College, Ames, Iowa. (54). 1906. C

Bennett, Charles W., Coldwater, Mich. (50). E

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Bennett, Henry C., Hotel Longacre, 157 West 47th St., New York, N. Y. (43).

Bennett, Homer Clark, The National College of Electro-Therapeutics, 210 W. Market St., Lima, O. (54). K

*Bennett, William Z., Ph. D., Director of Chemical Laboratory, Univ. of Wooster, Wooster, Ohio. (48). 1903. C

Benson, Frank Sherman, 214 Columbia Heights, Brooklyn, N. Y. (49).

Bentley, Gordon M., University of Tennessee, Knoxville, Tenn (54). F

*Bentley, I. Madison, Assistant Professor of Psychology, Cornell University, Ithaca, N. Y. (54). 1906. K

*Bentley, William B., Professor of Chemistry, Ohio University, Athens, Ohio. (51). 1903. C

Bentley, Wilson A., Jericho, Vt. (48).

Benton, Frank, U. S. Dept. Agriculture, Washington, D. C. (54). F

*Benton, John Robert, Ph. D., 132 A St., N.E., Washington, D. C. (51). 1906. B

Berg, William N., Assistant in Physiological Chemistry, Columbia Univ., New York, N. Y. (55). C

Bergen, Van Brunt, Shore Road and 77th St., Brooklyn, N. Y. (54). I

*Bergey, David H., S. E. cor. 34th and Locust Sts., Philadelphia, Pa. (48). 1903. K

*Bergström, John Andrew, Ph. D., Associate Professor of Psychology and Pedagogy, Indiana University, Bloomington, Ind. (50). 1901. I

Berkeley, Wm. N., Ph. D., Food Lab., Appraisers Stores, Philadelphia, Pa. (49). C

*Berkey, Charles Peter, Ph. D., Tutor in Geology, Columbia University, New York, N. Y. (50). 1905. E

Bernays, Augustus Charles, M. D., 3623 Laclede Ave., St. Louis, Mo. (50). F K

Bernheimer, Charles L., 43 E. 63d St., New York, N. Y. (49).

Berolzheimer, Daniel D., 11 E. 59th St., New York, N. Y. (55). C

Berry, Daniel, M. D., Carmi, Ill. (41). B C E

Berry, Edgar H., care Wyckoff, Seamans & Benedict, Ilion, N. Y. (50). **D**

*Berry, Edward W., Maryland Geological Survey, Baltimore, Md. (50). 1905. **G**

Berry, John Wilson, C. E., Pittston, Pa. (47).

*Bessey, Charles Edwin, Ph. D., LL.D., Univ. of Nebraska, Lincoln, Neb. (21). 1880. **G**

*Bessey, Ernst A., U. S. Dep't Agriculture, Washington, D. C. (49). 1901. **G**

Bessey, J. Mortimer, M. D., 1814 Adams St., Toledo, Ohio. (51). **K**

Best, George Newton, M. D., Rosemont, N. J. (54). **K**

*Bethune, Rev. C. J. S., 500 Dufferin Ave., London, Ontario, Canada. (18). 1875. **F**

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Bevier, George, Jr., Secy. of Spokane Science Club, 702 Alice Ave., Spokane, Washington. (55). **D**

Bevier, Miss Isabel, Univ. of Illinois, Urbana, Ill. (46). **C**

*Beyer, Geo. Eugene, Prof. of Biology, Tulane University, New Orleans, La. (54). 1906. **F G**

*Beyer, Prof. Samuel W., Iowa Agricultural College, Ames, Iowa. (47). 1900. **E**

*Bibbins, Arthur Barneveld, Curator and Instructor in Geology and Mineralogy, The Woman's College of Baltimore, The Somerset, 2600 Maryland Ave., Baltimore, Md. (54). 1906. **E**

*Bickmore, Prof. Albert S., Amer. Mus. Nat. History, Central Park, New York, N. Y. (17). 1880. **H**

Bicknell, George H., the University of Nebraska College of Medicine, Omaha, Neb. (55). **K**

Biddle, James G., 1024 Stephen Girard Building, Philadelphia, Pa. (33).

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Bierbaum, Christopher H., M. E., Consulting Engineer, 434 Prudential Building, Buffalo, N. Y. (53). **D**

Bierly, Prof. H. E., Editor Southern Educational Review, Grant Univ. Chattanooga, Tenn. (49). **H**

Bierwirth, Julius C., M. D., 137 Montague St., Brooklyn, N. Y. (51). **K**

*Bigelow, Prof. Frank H., U. S. Weather Bureau, Washington, D. C. (36). 1888. **A B**

Bigelow, Henry Bryant, Cohasset, Mass. (52).

*Bigelow, Maurice Alpheus, Ph. D., Adjunct Professor of Biology. Teachers' College, Columbia Univ., New York, N. Y. (51). 1903. **F**

*Bigelow, Robert Payne, Ph. D., Mass. Institute of Technology, Boston, Mass. (51). 1903. F

*Bigelow, S. Lawrence, Ph. D., Asst. Professor of General Chemistry, University of Michigan, Ann Arbor, Mich. (51). 1903. C

*Bigelow, W. D., Bureau of Chemistry, Department of Agriculture, Washington, D. C. (53). 1906. G

Biggs, Charles, 13 Astor Place, New York, N. Y. (50). I

Bigney, Andrew J., Professor of Biology and Geology, Moores Hill College, Moores Hill, Ind. (50). E F

Billings, Miss E., 279 Madison Ave., New York, N. Y. (50). I

Bird, Henry, Rye, N. Y. (55). F

*Birge, Edward A., Dean of College of Letters and Science, University of Wisconsin, Madison, Wis. (53). 1905. G I

BISHOP, HEBER R., Mills Building, New York, N. Y. (36).

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Bishop, Mrs. Josephine Hall, 2309 Washington St., San Francisco, Cal. (51). H

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Bishopp, Fred. C., U. S. Dept. Agriculture, Washington, D. C. (54). F

*Bissell, G. W., Professor of Mechanical Engineering, Iowa State College, Ames, Iowa. (53). 1905. D

Bissell, Leslie Dayton, Ph. D., St. Paul's School, Concord, N. H. (50) B

Bissing, William F., 49 Wall St., New York, N. Y. (55). B

Bitner, Henry F., Ph. D., Teacher of Natural Science, First Pennsylvania State Normal School, Millersville, Pa. (52). B C G

*Bitting, Mrs. Katherine Golden, Lafayette, Ind. (42). 1897. G

*BIXBY, COL. W. H., Corps of Engineers, U. S. A., U. S. Engineer's Office, Room 506, Federal Bldg., Chicago, Ill. (34). 1892. D

*Black, Homer V., Georgia School of Technology, Atlanta, Ga. (52). 1906. C

Black, N. Henry, 15 Ellery St,. Cambridge, Mass. (50). B

Blackall, Clarence Howard, Architect, 1 Somerset St., Boston, Mass. (50). D

Blackburn, Isaac Wright, M. D., Pathologist, Government Hospital for the Insane, Washington, D. C. (55). K

Blackmore, Henry S., 206 S. 9th Ave., Mount Vernon, N. Y. (49).

Blackshear, Edward Levoisier, Principal of the Prairie View State Normal and Industrial College, Prairie View, Texas. (52). H I

Blackwelder, Eliot, University of Wisconsin, Madison, Wis. (55). E

*Blain, Alexander W., Jr., 131 Elmwood Ave., Detroit, Mich. 1906. (52).

*Blair, Andrew Alexander, 406 Locust St., Philadelphia, Pa. (44). 1896. C

Blair, Mrs. Eliza N., Manchester, N. H. (40).

*Blake, Clarence J., M. D., 226 Marlborough St., Boston, Mass. (24). 1877. B F

*Blake, Edwin Mortimer, 1910 Addison St., Berkeley, Cal. (43). 1901. A

*Blake, Francis, Auburndale, Mass. (23). 1874. A B

Blake, John Bapst, M. D., 178 Beacon St., Boston, Mass. (50). F K

*Blake, William Phipps, Mill Rock, New Haven, Conn. (54). 1906. E

Blakeman, Mrs. Birdseye, 9 E. 44th St., New York, N. Y. (49).

Blaker, Ernest, Cornell Univ., Ithaca, N. Y. (51). B

Blakeslee, Albert Francis, care Botanisches Institute Halle, a. S., Germany. (52).

Blakeslee, Olin Safford, Magnolia, Colo. (50). B D E

Blakiston, Kenneth M., 1012 Walnut St., Philadelphia, Pa. (54).

*Blanchard, Arthur Horace, C. E., Assistant Professor Engineering, Brown University, Providence, R. I. (52). 1905. B D

Bland, John Carlisle, Engineer of Bridges, Penna. Lines West of Pittsburg, 1003 Penn Ave., Pittsburg, Pa. (51). D

Blankinship, Joseph William, Ph. D., Professor of Botany, Montana State College, Bozeman, Montana. (51). G

Blasdale, Walter Charles, Ph. D., Instructor in Chemistry, University of California, Berkeley, Cal. (50). C

Blauvelt, Harrington, Mining Engineer, Prescott, Ariz. (51) D E

*Bleile, Albert M., M. D., State University, Columbus, Ohio. (37). 1896. F

Blish, W. G., Niles, Mich. (33). B D

*Bliss, Charles B., Ph. D., Hampden, Mass. (49). 1906. H I

Bliss, Hon. Cornelius N., P. O. Box 1499, New York, N. Y. (49).

Bliss, Gilbert Ames, Princeton Univ., Princeton, N. J. (55). A

*Blodgett, Frederick H., Maryland Agric. College and Experiment Station, College Park, Md. (52). 1905. G

Bloodgood, John H., 6 W. 40th St., New York, N. Y. (49).

Bloodgood, Joseph Colt, Asst. Prof. Surgery, Johns Hopkins Univ., Baltimore, Md. (55). F

Blount, Henry Fitch, "The Oaks," Washington, D. C. (32). B I

Blum, Sanford, M. D., 1243 Franklin St., San Francisco, Cal. (52). K

Blum, William, Univ. of Utah, Salt Lake City, Utah. (55). C

Boas, Emil L., 37 Broadway, New York, N. Y. (50). I

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*Bodine, Donaldson, Professor of Geology and Zoölogy, Wabash College. Crawfordsville, Ind. (45). 1899. E F

Boerner, Wunibald R., Ravinia, Ill. (54). D

Bogert, Marston Taylor, Havemeyer Hall, Columbia Univ, New York, N. Y. (47). 1900. **C**

*Bolce, Harold, 3222 Q St. N. W., Washington, D. C. (52). 1906. **B F G I**

Bolles, Newton Alden, 1457–59 Ogden St., Denver, Colo. (50). **C**

*Bolley, Henry L., Professor of Botany and Zoölogy, Agricultural College, North Dakota. (39). 1892. **F G**

*Bolton, Thaddeus L., Ph. D., Dept. Philosophy, University of Nebraska, Lincoln, Neb. (50). 1901. **H I**

*Bond, Geo. M., 141 Washington St., Hartford, Conn. (33). 1885. **D**

Bond, R. I., M. D., Hartshorne, Ind. Ter. (50). **K**

Bondurant, Eugene Du Bose, M. D., Prof. Pathology and Bacteriology, University of Alabama, Mobile, Ala. (54). **K**

*Bonnet, Frederic, Jr., Worcester Polytechnic Institute, Worcester, Mass. (53). 1906. **C**

*Bookman, Samuel, Ph. D., 9 E. 62d St., New York, N. Y. (47), 1900. **C**

Boon, John Daniel, Professor of Physics, Chemistry and Geology, Polytechnic College, Ft. Worth, Texas. (50). **B C E**

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Booth, Edward, Instructor in Chemistry, Univ. of California, Berkeley, Cal. (50). **C**

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Boucek, Anthony J., M. D., 624 Chestnut St., Allegheny, Pa. (51). **K**

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*Boutwell, John Mason, U. S. Geol. Survey, Washington, D. C. (46). 1905. **E**

*Bowditch, Charles P., 28 State St., Boston, Mass. (43). 1897. **H**

*Bowditch, Prof. H. P., Jamaica Plain, Mass. (28). 1880. **B F H**

Bower, William Clinton, M. D., Lebanon, Kansas. (55). **K**

Bowker, R. R., 298 Broadway, New York, N. Y. (43). **B**

Bowlus, E. Lingan, Professor of Biology, Monmouth College, Monmouth, Ill. (50). **F**

Bowman, Charles Henry, Professor of Mechanics and Electrical Engineering, State School of Mines, Butte, Mont. (51). **D**

*Bownocker, J. A., Professor of Inorganic Geology, Ohio State University, Columbus, Ohio. (48). 1905. **E**

*Bowser, Prof. E. A., Rutgers College, New Brunswick, N. J. (28). 1881.

*Boyd, James E., Ohio State Univ., Columbus, Ohio. (46). 1899. **B D**

*Boyé, Martin H., M. D., Coopersburg, Pa. (1). 1896. **C**

Brace, Edith M., Western Maryland College, Westminster, Md. (54). F G

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BRACKENRIDGE, GEORGE W., San Antonio, Texas. (41). I

Brackett, Byron B., Ph. D., Clarkson School of Technology. Potsdam, N. Y. (46). B

*Brackett, Prof. C. F., Princeton University, Princeton, N. J. (19). 1875. B

*Brackett, Frank Parkhurst, Professor of Mathematics, Pomona College, Claremont, Cal. (50). 1906. A

Brackett, Mary M., 604 West 115th St., New York, N. Y. (54) G

Brackett, Richard N., Clemson College, S. C. (37). 1891. C E

*Bradford, Royal B., Rear Admiral, U. S. N., Navy Dept., Washington. D. C. (31). 1891. B D

BRADLEY, ARTHUR C., Newport, N. H. (43).

Bradley, C. E., Prof. of Chemistry, Forest Grove Universlty, Forest Grove, Oregon. (54). C

Bradley, Charles S., 41 Park Row, New York, N. Y. (40).

Bradley, Charles Whiting, 1064 Ellicott Square, Buffalo, N. Y. (51). D

Bradley, J. Chester, Cornell University, Ithaca, N. Y. (54). F

BRADLEY, MILTON, Springfield, Mass. (44). B

BRADLEY, M. J., 373 Fulton St., Brooklyn, N. Y. (43).

BRADLEY, STEPHEN ROWE, Nyack, New York. (51).

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Brainerd, Erastus, Seattle, Wash. (52).

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*Branner, Prof. John C., Stanford University, Cal. (34). 1886. E F

Brannon, Melvin Amos, 207 Chestnut St., Grand Forks,N. Dak. (55).

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Brassill, Miss Sarah Ellen, South Weymouth, Mass. (47). F G

Braunnagel, Jules L. A., M. D., P. O. Box 925, San Antonio, Texas. (50). F

*Bray, William L., Professor of Botany, Univ. of Texas, Austin, Texas. (49). 1901. G

Brayton, Sarah H., M. D., The Hereford, Evanston, Ill. (33).

Breed, Robert Stanley, Ph. D., Department of Biology and Geology, Allegheny College, Meadville, Pa. (51). F

Breese, Burtis Burr, Prof. of Psychology, Univ. of Cincinnati, Cincinnati, Ohio. (54). K

Brett, George Monroe, Asst. Prof. of Mathematics, University of Vermont, Burlington, Vt. (54). A D

Brett, George P., 30 Irving Place, New York, N. Y. (49).

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*Brewer, Prof. Wm. H., 418 Orange St., New Haven, Conn. (20). 1875. **E F I**

Brewster, Edwin Tenney, Instructor in Natural Sciences, Phillips Academy, Andover, Mass. (51).

Brewster, Frank H., M. E., 154 Fargo Ave., Buffalo, N. Y. (51). **D**

Brewster, Mary Jones, M. D., Prof. Physiology and Hygiene, Smith College, Northampton, Mass. (54). **K**

Brice, Judge Albert G., 901 Hennen Bldg., New Orleans, La. (32). **H**

*Bridge, Norman, M. D., 217 S. Broadway, Los Angeles, Cal. (51). 1906. **K**

Briggs, Edward Cornelius, Harvard Medical School, Boston, Mass. (50). **F K**

*Briggs, Lyman J., U. S. Dept. Agriculture, Washington, D. C. (48). 1901. **B**

Briggs, Wallace Alvin, M. D., 1300 I St., Sacramento, Cal. (51). **K**

*Brigham, Albert Perry, Professor of Geology, Colgate Univ., Hamilton, N. Y. (41). 1900. **E**

Brigham, William T., Director of B. P. Bishop Museum of Polynesian Ethnology and Natural History, Honolulu, T. H. (54). **H**

Bright, Richard Riggs, Ordnance Bureau, Navy Dept., Washington, D. C. (52). **D**

*Brill, George M., Consulting Engineer, 1134 Marquette Building, Chicago, Ill. (51). 1906. **D**

Brill, Nathan Edwin, M. D., 48 West 76th St., New York, N. Y. (54). **H K**

Brinckerhoff, Walter Remsen, Instructor in Pathology, Harvard Medical School, Boston, Mass. (55). **K**

Bristol, John I. D., Metropolitan Building, New York, N. Y. (49).

*Bristol, Wm. H., Stevens Institute, Hoboken, N. J. (36). 1894. **A B D**

Brittin, Lewis H., Ansonia, Conn. (52). **H**

*Britton, N. L., Ph. D., N. Y. Botanical Garden, Bronx Park, New York, N. Y. (29). 1882. **E G**

Britton, Wiley, Special Pension Examiner, Springfield, Mo. (40). **F**

*Britton, Wilton Everett, Ph. D., State Entomologist, Agricultural Ex. Sta., New Haven, Conn. (54). 1906. **F**

Broadhurst, Jean, Inst. in Botany, State Normal School, Trenton, N. J. (54). **G**

Brock, Luther S., M. D., Morgantown, W. Va. (51). **K**

Brock, Reginald Walter, Professor of Geology, School of Mining, Kingston, Ont., Canada. (54). **E**

*Brock, Robert C. H., 1612 Walnut St., Philadelphia, Pa. (54). 1906.
Brodhead, Mark, 1733 19th St., N.W., Washington, D. C. (52).
Brodie, Paul Thomas, Professor of Mathematic s and Civil Engineering, Clemson College, Clemson College, S. C. (50). **A D**
Bronson, Dr. E. B., 10 W. 49th St., New York, N. Y. (49).
Brookover, Charles, Buchtel College, Akron, Ohio. (55). **F**
Brooks, Albert A., High School, Kansas City, Kan. (50). **F G**
*Brooks, Alfred Hulse, U. S. Geological Survey, Washington, D. C. (52). 1905. **E**
Brooks, Charles, Durham, N. H. (53). **G**
Brooks, Charles Edward, Lake Roland, Md. (52). **A**
Brooks, Rev. Earle Amos, Waverly, W. Va. (50). **F**
Brooks, J. Ansel, Instructor in Mech. Drawing, Brown University, Providence, R. I. (54). **D**
Brooks, James C., 430 Washington Ave., Philadelphia, Pa. (54). **D**
*Brooks, Wm. Keith, Ph. D., Johns Hopkins Univ., Baltimore, Md. (52). 1903. **F**
Brooks, Prof. Wm. P., Amherst, Mass. (38). **C F**
*Brooks, Wm. R., D. Sc., Director Smith Observatory and Professor of Astronomy, Hobart College, Geneva, N. Y. (35). 1886. **A B D**
Broome, G. Wiley, M. D., Missouri Trust Bldg., St. Louis, Mo. (51). **K**
*Brown, Amos Peaslee, Ph. D., Assistant Professor of Geology and Mineralogy, Univ. of Pennsylvania, Philadelphia, Pa. (50). 1906. **E**
*Brown, Arthur Erwin, Secy. Zoological Society of Philadelphia, 1208 Locust St., Philadelphia, Pa. (51). 1905. **F**
Brown, Austin H., Jr., Genl. Mgr. Trinity Copper Co., Kennett, Cal. (52). **D**
Brown, Calvin S., D. Sc., Ph. D., University, Miss. (54). **E F G**
Browne, Charles A., Jr., Ph. D., Exper. Station, Audubon Park, New Orleans, La. (52).
Brown, Charles W., Dept. Geology, Brown Univ., Providence, R. I. (54). **E**
Brown, Rev. Clement, 1440 M St., N.W., Washington, D. C. (52)
Brown, David Walter, Ph. D., Patent Counsel, 5 Beekman St., New York, N. Y. (55). **D**
Brown, Edgar, Botanist in charge of Seed Laboratory, Department Agriculture, Washington, D. C. (52). **G**
Brown, Elisha Rhodes, President Stafford Savings and National Banks, 50 Silver St., Dover, N. H. (50). **I**
*Brown, Ernest William, Sc. D., Professor of Mathematics, Haverford College, Haverford, Pa. (53). 1906. **A B**
Brown, Fay Cluff, Instructor in Physics, Univ. of Illinois, Urbana, Ill. (55). **B**

Brown, George Lincoln, Professor of Mathematics and Astronomy, State Agricultural College, Brookings, South Dakota, (55). **A**

Brown, Glenn V., Plainfield, N. J. (51). **B C E**

Brown Harold W., Delaware College, Newark, Del. (48). **B C**

Brown, John C., Instructor in Zoology, Univ. of Minnesota, Minneapolis, Minn. (52). **F K**

*Brown, Joseph Stanford, 489 Fifth Ave., New York, N. Y. (50). 1906. **D**

Brown, Linus Weed, 741 Carondelet Street, New Orleans, La. (53). **D**

Brown, Lucius Polk, 310 Union St., Nashville, Tenn. (54). **C E**

Brown, Newton H., College Station, Texas. (48). **B D**

*Brown, Robert, Yale University Observatory, New Haven, Conn. (11). 1874. **A**

*Brown, Mrs. Robert, Observatory Place, New Haven, Conn. (17). 1874.

Brown, Robert Marshall, Instructor in Geography, State Normal School, Worcester, Mass. (48). **E**

Brown, Samuel B., Morgantown, W. Va. (40). **E**

*Brown, Stewardson, 20 E. Penn St., Germantown, Pa. (50). 1906. **I**

Brown, W. L., 42 West 72d St., New York, N. Y. (50). **I**

Browne, W. R., C. E., 413 4th Ave., Pittsburg, Pa. (54). **D**

Brownell, Silas B., 71 Wall St., New York, N. Y. (36).

Browning, Charles Clifton, M. D., Pattenger Sanatorium, Monrovia, Cal. (51). **K**

*Browning, Philip Embury, Kent Chemical Laboratory, Yale University, New Haven, Conn. (46). 1903. **C**

*Browning, William, M. D., 54 Lefferts Place, Brooklyn, N. Y. (53). 1906. **K**

Bruckner, Arthur, College of the City of New York, New York, N Y. (55.) **B**

*Brues, C. T., Milwaukee Public Museum, Milwaukee, Wis. (54). 1906. **F**

Bruggerhof, F. W., 36 Cortlandt St., New York, N. Y. (49).

Brundage, Albert H., M. D., 1073 Bushwick Ave., Brooklyn, N. Y. (43). **F G H**

Bruner, Frank G., care of Board of Education, 808 Tribune Building, Chicago, Ill. (55) **H K**

*Bruner, Henry Lane, Ph. D., Professor of Biology, Butler College, Indianapolis, Ind. (30). 1906. **F**

*Bruner, Lawrence, Professor of Entomology, Univ. of Nebraska, Lincoln, Neb. (50). **F**

Brunton, David William, Mining Engineer, 865 Grant Ave. Denver, Colo. (50). **D E**

*Brush, Charles F., 1003 Euclid Ave., Cleveland, Ohio. (35). 1886. **B**

*Brush, Prof. George J., Yale Univ., New Haven, Conn. (4). 1874. C E

Bryan, Enoch A., President, The State College of Washington, Pullman, Wash. (54). I

Bryan, Joseph Hammond, 818 17th St., Washington, D. C. (52).

Bryan, Dr. Walter, Instructor in Biology, College of City of New York, 139 East 21st St., New York, N. Y. (52). F

Bryan, William Alanson, B. P. Bishop Museum, Honolulu, T. H. (55)

*Bryan, Prof. William L., Indiana Univ., Bloomington, Ind. (49). 1900. H

Bryant, Miss Dixie Lee, Ph. D., Nahant, Mass. (42). E

*Bryant, Henry G., 2013 Walnut St., Philadelphia, Pa. (51). 1905. E

*Bryant, Owen, Cohasset, Mass. (54). 1906. K

Bryant, W. Sohier, M. D., 48 West 40th St., New York, N. Y. (54). K

Bryson, Andrew, C. E., New Castle, Del. (51). D

Buchanan, James Isaac, Vice-President Pittsburg Trust Co., Conestoga Building, Pittsburg, Pa. (51). I

Bucher, John Emery, Associate Professor of Organic Chemistry, Brown University, Providence, R. I. (54). C

Buchholz, Carl Waldemar, Chief Engineer, Erie R.R. Co., 21 Cortlandt St., New York, N. Y. (51). D E

*Buchner, Edward Franklin, Ph. D., Professor of Philosophy and Education, University of Alabama, University, Ala. (49). 1901. H

*Buckhout, W. A., School of Agriculture, State College, Pa. (20). 1881. G

Buckingham, Chas. L., 38 Park Row, New York, N. Y. (28).

*Buckley, Ernest Robertson, Ph. D., Director Bureau of Geology and Mines and State Geologist of Missouri, Rolla, Mo. (52). 1905. E

Budington, Robert A., Dept. Zoology, Wesleyan Univ., Middletown, Conn. (52). F K

*Buffum, Burt C., Professor of Agriculture, Agricultural College, Laramie, Wyo. (42). 1906. G

Bull, Coates P., Assistant Professor Agr., Univ. of Minnesota, St. Anthony Park, Minn. (52). D G

*Bull, Prof. Storm, University of Wisconsin, Madison, Wis. (44). 1897. D

*Bullard, Warren Gardner, Ph. D., Associate Professor of Mathematics, Syracuse University, Syracuse, N. Y. (50). 1906. A

Bullene, Mrs. Emma F. Jay, 329 16th St., Denver, Colo. (50) H.

Bullett, James B., M. D., Professor of Anatomy, Univ. of Mississippi, University P. O., Miss. (55). K

*Bumpus, H. C., Am. Mus. Nat. Hist., New York, N. Y. (49). 1900.
*Burbank, Luther, Santa Rosa, Cal. (50). 1901. **G**
Burbidge, Frederick, 510 Empire State Building, Spokane, Wash. (50). **D E**
Burchard, Anson W., 44 Broad St., New York, N. Y. (51). **D**
Burdick, Lewis Dayton, Oxford, N. Y. (52).
*Burgess, Albert F., State House, Columbus, O. (54). 1906. **F**
*Burgess, Edward S., 11 W. 88th St., New York, N. Y. (47). 1901. **G**
Burgess, George Kimball, Ph. D., Bureau of Standards, Washington, D. C. (55). **B**
*Burgess, Thomas J. W., M. D., Medical Supt. Protestant Hospital for the Insane, Montreal, Can. (38). 1889. **G E**
Burk, W. E., Chief Chemist and Bacteriologist, Louisville Water Co., 1112 Hepburn Ave., Louisville, Ky. (55). **C K**
Burke, M. D., C. E., N. E. Cor. 4th and Walnut Sts., Cincinnati, Ohio. (50). **A B C D E**
Burke, Robert E., Boston Normal School, Boston, Mass. (50). **C.**
*Burkett, Charles William, Ph. D., Professor of Agriculture, N. C. College of Agriculture and Mechanic Arts, West Raleigh, N. C. (53) 1906. **C**
Burnett, Charles Theodore, Ph. D., Instructor in Psychology, Bowdoin College, Brunswick, Me. (54). **F K**
*Burnette, F. H., Professor of Horticulture, Louisiana University, Baton Rouge, La. (54). 1906. **F G**
Burnham, George, Jr., C. E., Burnham, Williams & Co., Baldwin Locomotive Works, 214 N. 34th St. Philadelphia, Pa. (51). **D**
*Burr, Prof. William H., Columbia University, New York, N. Y. (31). 1883.
Burrell, Rámon Haddock, M. D., Creighton, Neb. (51). **K**
*Burrill, Thomas J., Professor of Botany, University of Illinois, Urbana, Ill. (53). 1905. **G**
*Burt, Edward Angus, Ph. D., Professor of Natural History, Middlebury College, Middlebury, Vt. (50). 1901. **G**
*Burton, Prof. Alfred E., Mass. Inst. Technology, Boston, Mass. (40). 1906. **E**
Burton, E. F., Demonstrator in Physics, University of Toronto, Toronto, Ontario, Canada. (53). **B**
*Burton, Hon. Theodore E., M. C., House of Representatives, Washington, D. C. (52). 1905. **I**
*Burton-Opitz, Russell, Instructor in Physiology, Columbia University, New York, N. Y. (52). 1905. **K**
*Busch, Frederick Carl, M. D., 145 Allen St., Buffalo, N. Y. (49) 1906. **F**
Bush, John C. F., M. D., Wahoo, Neb. (51). **K**

*Bushnell, D. I., Jr., Assistant in Archæology, Peabody Museum, Cambridge, Mass. (52). 1903. **H**

*Butler, Amos W., Secretary Board of State Charities, Indianapolis, Ind. (30). 1885. **F H**

Butler, Matthew Joseph, Deputy Minister and Chief Engineer, Dept. Railways and Canals, Ottawa, Canada. (51). **D**

Butterfield, Arthur Dexter, Professor of Mathematics and Mechanics, University of Vermont, Burlington, Vt. (50). **A D**

Butterfield, Elmore E., Instructor in Pathology, Univ. of Michigan, Ann Arbor, Mich. (53). **F**

Butts, Edward Pontany, C. E, Chief Engineer, Am. Writing Paper Co., Holyoke, Mass. (51). **D**

Buxton, Bertram H., Professor Experimental Medicine, Cornell Medical College, 414 East 26th St., New York, N. Y. (54). **F G**

Byrnes, Owen, Mining Engineer, Gould, Montana. (51). **D E**

*Cabot, Samuel, Manufacturing Chemist, 70 Kilby St., Boston, Mass. (50). 1906. **C**

*Cady, Hamilton Perkins, Assistant Professor of Chemistry, University of Kansas, Lawrence, Kansas. (52). 1906. **B C**

*Cady, Walter G., Ph. D., Wesleyan Univ., Middletown, Conn. (49). 1906. **B**

*Cain, William, Professor of Mathematics, University of North Carolina, Chapel Hill, N. C. (50). 1901. **A D**

*Cajori, Florian, Professor of Mathematics, Colorado College, Colorado Springs, Colo. (50). 1901. **A**

Caldwell, Benjamin Palmer, Ph. D., Assistant Professor of Chemistry, Tulane Univ., New Orleans, La. (55). **C**

*Caldwell, Prof. Otis W., State Normal School, Charleston, Ill. (49). 1902. **G**

Calhoun, Fred H. H., Ph. D., Professor of Geology and Mineralogy, Clemson College, S. C. (54). **E**

*Calkins, Gary N., Ph. D., Adjunct Professor of Zoölogy, Columbia University, New York, N. Y. (49). 1901. **F**

Calkins, Marshall, M. D., 14 Maple St., Springfield, Mass. (29).

*Calvert, Philip P., Ph. D., Instructor in Zoology, University of Pennsylvania, Philadelphia, Pa. (50). 1903. **F**

*Calvert, Prof. Sidney, Univ. of Missouri, Columbia, Mo. (47). 1903. **C**

*Calvin, Samuel, Director Iowa Geol. Survey, Iowa City, Iowa, (37). 1889. **E F**

*Cameron, Frank K., Ph. D., Chemist, Bureau of Soils, U. S. Dept. Agriculture, Washington, D. C. (49). 1901. **C**

Cameron, John E., Professor Natural History, Cedar Rapids High School, Cedar Rapids Ia. (54). **G**

Cammann, Hermann H., 51 Liberty St., New York, N. Y. (49).
*Campbell, Douglas H., Professor of Botany, Stanford University, Cal. (34). 1888. G
*Campbell, Henry Donald, Professor Geology and Biology, Washington and Lee University, Lexington, Va. (52). 1905. E F G
Campbell, Leslie Lyle, Ph. D., Harvard University, Cambridge, Mass. (48).
*Campbell, Marius Robison, U. S. Geological Survey, Washington, D. C. (52). 1905. E
Campbell, Michael, M. D., Supt. Lyons View Insane Asylum, Knoxville, Tenn. (54). K
*CAMPBELL, WILLIAM WALLACE, Director of Lick Observatory, Mt. Hamilton, Cal. (50). 1901. A
*Cannon, George Lyman, Instructor in Geology, East High School, Denver, Colo. (39). 1901. E
*Cannon, W. A., Ph. D., Desert Botanical Laboratory, Tucson, Arizona. (52). 1905. G
*Cannon, Walter Bradford, Asst. Prof. Physiology, Harvard University, Cambridge, Mass. (54). 1906. K
Canter, Hall, Ph. D., Professor of Chemistry, Randolph-Macon College, Ashland, Va. (54). C
Carey, Everett P., San Jose High School, San Jose, Cal. (50). B C
*Carhart, Prof. Henry S., Univ. of Michigan, Ann Arbor, Mich. (29). 1881. B
*Carleton, M. A., U. S. Dept. Agriculture, Washington, D. C. (42), 1894. G
*Carlson, Anton Julius, Ph. D., Associate in Physiology, Univ. of Chicago. Chicago, Ill. (52). 1906. K
*Carmalt, William Henry, Professor of Surgery, Yale University, New Haven, Conn. (54). 1906. K
Carnaghan, Edwin Dixon, Mechanical Engineer, Villa Corona, Do., Mexico. (50). D
Carnegie, Thomas Morrison, 542 Fifth Ave., New York, N. Y. (50). F
Carpenter, Rev. Charles Knapp, Pastor of First M. E. Church, Polo, Illinois. (55). F
Carpenter, Ford A., U. S. Weather Bureau, San Diego, Cal. (44) B
Carpenter, Frances Ann, M. D., 521 Hanover St., Baltimore, Md. (54). K
*Carpenter, Franklin R., Ph. D., Mining Expert, 508 Equitable Bldg., Denver, Colo. (50). 1906. D E
*Carpenter, Louis G., Agric. College, Fort Collins, Colo. (32). 1889. A B

Carr, William Kearny, 1413 K St., N.W., Washington, D.C. (52).

*Carr, William Phillips, M. D., 1418 L St. N. W., Washington, D. C. (51). 1906. K

Carrington, Thomas Spees, Surgeon in charge Am. Hospital and Training School for Nurses, Constantinople, Turkey. (55). K

*Carroll, James, M. D., 1st Lieut. Asst. Surgeon. U. S. A., Curator Army Medical Museum, Washington, D. C. (50). 1903. F K

Carrow, Flemming, M. D., University of Michigan, Ann Arbor. Mich. (51). K

Carruth, John G., Indiana Ave. and Rosehill St., Philadelphia, Pa. (54). D

Carson, Lewis Clinton, Asst. Prof. of Philosophy, Indiana Univ., Bloomington, Ind. (54). I

Carson, Shelby Chadwick, M. D., Greensboro, Ala. (51). K

*CARTER, JAMES C., 277 Lexington Ave., New York, N. Y. (36). 1906.

*Carter, James Madison G., M. D., Waukegan, Ill. (39). 1895. F

Carter, John E., Knox and Coulter Sts., Germantown, Pa. (33). B H

Carter, Marion H., 504 West 143d St., New York, N. Y. (49).

Carty, John Joseph, Chief Engineer N. Y. Telephone Co., 15 Dey St., New York, N. Y. (54). D

*Carus, Paul, Ph. D., Editor Open Court Pub. Co., 1322 Wabash Ave., Chicago, Ill. (40). 1895. H

Cary, Mrs. Elizabeth M. L., 184 Delaware Ave., Buffalo, N. Y. (45). E

Case· Eckstein, Case School of Applied Science, Cleveland, Ohio. (47).

*Case, Ermine Cowles, Prof. of Chemistry and Geology, State Normal School, Milwaukee, Wis. (50). 1906. B C E

*Casey, Thomas L., Major of Engineers, U. S. A., P. O. Drawer 71, St. Louis, Mo. (38). 1892. D F

*Castle, W. E., Asst. Professor Zoölogy, Harvard Univ., Cambridge, Mass. (52). 1903. F

Cathcart, Miss J. R., care Munroe & Co., 7 Rue Scribe, Paris, France. (50).

*Catlin, Charles A., 133 Hope St., Providence, R. I. (33). 1895. C

*Cattell, H. W., M. D., 3709 Spruce St., Philadelphia, Pa. (50). 1901. K

*CATTELL, PROF. JAMES MCKEEN, Columbia Univ., New York, N. Y. (44). 1896. B F H I

Cerna, Dr. David, Monclova, Coahuila, Mexico. (51).

Chadbourn, Erlon R., Lewiston, Me. (29).

Chadwick, George Halcott, Geologist and Palæontologist, Ward's Nat. Science Establishment, 76 College Ave., Rochester, N. Y. (54). E

Chadwick, Leroy S., M. D., 1824 Euclid Ave., Cleveland, Ohio. (51).
*Chaillé, Stanford E., M. D., LL.D., Dean of Medical Department, Tulane University, New Orleans, La. (51). 1903. K
*Chamberlain, Charles Joseph, Dept. of Botany, University of Chicago, Chicago, Ill. (50). 1902. G
Chamberlain, Clark Wells, Professor of Physics, Denison University, Granville, Ohio. (53). B
Chamberlain, Frederic M., Bureau of Fisheries, U. S. Department of Commerce and Labor, Washington, D. C. (51). F
Chamberlain, Paul Mellen, Prof. of Mechanical Engineering, Lewis Institute, Chicago, Ill. (51). D
Chamberlin, Rollin Thomas, Hyde Park Hotel, Chicago, Ill. (50). C E
*Chamberlin, T. C., Head of Dept. of Geology, Univ. of Chicago, Chicago, Ill. (21). 1877. B E F H
Chambers, Frank R., 842 Broadway, New York, N. Y. (50).
Chambers, Will Grant, Professor of Psychology and Education, State Normal School, Greeley, Colo. (52). H
*Chambliss, Charles E., Associate Professor of Zoology and Entomology, Clemson College, Clemson College, S. C. (51). 1906. F
Chambliss, Hardee, Ph. D., General Chemical Co., Laurel Hill L. I., N. Y. (55). C
Chancellor, Wm. E., Supt. of Schools, Paterson, N. J. (52).
*Chandler, Prof. C. F., School of Mines, Columbia University, New York, N. Y. (19). 1875. C
*Chandler, Charles Henry, Professor of Mathematics, Ripon College, Ripon, Wis. (28). 1883. A
Chandler, Clarence Austin, Mechanical Engineer, East Bridgewater, Mass. (52). D
Chandler, Elwyn Francis, Assistant Professor of Mathematics, University of North Dakota, University, N. Dak. (50). A B
Chandler, Richard E., Stillwater, Oklahoma. (46). B D
Chaney, Prof. Lucian W., Carleton College, Northfield, Minn, (45).
*Chant, Clarence Augustus, Lecturer in Physics, University of Toronto, Toronto, Can. (54). 1906. A B
*Chanute, O., 413 E. Huron St., Chicago, Ill. (17). 1877. D I
Chapman, Robert Hollister, U. S. Geological Survey, Washington, D. C. (52). E
Chappell, H. G., D. D. S., 630 Eldorado St., Oakland, California. (55). K
Charles, Fred. L., Professor of Biology, Northern Illinois State Normal School, De Kalb, Ill. (52). F G
Charlton, Orlando Clarke, Univ. of Chicago, Chicago, Ill. (51). E F G

Chase, Mrs. Agnes, Dept. of Agriculture, Washington, D. C., (54). G

*Chase, Frederick L., Yale University Observatory, New Haven, Conn. (43). 1896. A

Chase, George Colby, President and Professor of Psychology, Bates College, Lewiston, Me. (54). K

Chase, Harry Gray, Assistant Professor of Physics, Tufts College. Mass. (52). B

Chase, Ira Carleton, M. D., Fort Worth, Texas. (52).

Chase, R. Stuart, 53 Summer St., Haverhill, Mass. (18). F

*Chauvenet, Wm. M., Mining Engineer, 620 Chestnut St., St. Louis, Mo. (50). 1901. C D

*Cheesman, T. M., M. D., Garrison-on-Hudson, N. Y. (50) 1901. K

Cheever, Clarence A., M. D., 1531 Blue Hill Ave., Boston, Mass. (53). G

Cheney, Newel, Falconer, R. F. D., N. Y. (52).

Chesnut, Victor King, Chemist Montana Agrl. Ex. Sta., Bozeman, Mont. (54). C G

*Chester, Colby M., Rear Admiral, U. S. N., Superintendent Naval Observatory, Washington, D. C. (28). 1897. E

Chester, Wayland Morgan, Associate Professor of Biology, Colgate University, Hamilton, N. Y. (50). F

*Chickering, J. W., The Portner, Washington, D. C. (22). 1877. G I

Chilcott, Ellery Channing, Professor of Geology, Agricultural College, Brookings, S. D. (50). E

*Child, Charles Manning, Instructor in Zoology, University of Chicago, Chicago, Ill. (50). 1901. F

Childs, James Edmund, Civil Engineer, 300 W. 93d St., New York, N. Y. (51). D

Chisholm, A. Arthur, M. D., Kelseyville, Cal. (51). K

Chisholm, Hugh J., 813 Fifth Avenue, New York, N. Y. (50).

Chisolm, George E., 19 Liberty St., New York, N. Y. (50).

*Chittenden, Frank Hurlbut, U. S. Dept. Agriculture, Washington, D. C. (48). 1901. F

*Chittenden, J. Brace, Ph. D., Department of Pure Mathematics, Brooklyn Polytechnic Institute, Brooklyn, N. Y. (53). 1906. A

*Chittenden, Russell H., Director of Sheffield Scientific School, Yale University, New Haven, Conn. (50). 1901. C F

Chittenden, Thomas A., Instructor in Mechanical Engineering, A. and M. College, W. Raleigh, N. C. (50). D

*Christie, James, Chief Mech. Engineer Am. Bridge Co., 100 Rochelle Ave., Wissahickon, Philadelphia, Pa. (33). 1894. D

Church, Arthur L., 500 N. Broad St., Philadelphia, Pa. (54).

Church, Royal Tyler, Turin, N. Y. (38). D F

*Churchill, William, care Corning Glass Works, Corning, N. Y. (52). 1905. H

Churchill, William W., Vice-President Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York, N. Y. (51). D

Churchward, Alexander, General Electric Co., Schenectady, N. Y. (52).

*Chute, Horatio N., Instructor in Physical Sciences, High School, Ann Arbor, Mich. (34). 1889. A B C

*CILLEY, FRANK H., Mass. Inst. Technology, Boston, Mass. (49). 1901. A B D

*Clapp, Miss Cornelia M., Mt. Holyoke College, South Hadley, Mass. (31). 1883. F

*Clapp, Frederick Gardner, U. S. Geological Survey, Washington, D. C. (51). 1906. E

Clark, Alexander S., Westfield, N. J. (33).

Clark, Arthur W., care J. Ellwood Lee Co., Conshohocken, Pa. (54).

*Clark, Austin Hobart, 107 Audubon Road, Boston, Mass. (52). 1906. F

Clark, Miss Bertha May, Instructor in Physics, The Woman's College, Baltimore, Md. (52). B

Clark, Clarence Munroe, Bullitt Building, Philadelphia, Pa. (54). I

Clarke, Miss Cora H., 91 Mt. Vernon St., Boston, Mass. (47). F G

Clark, Edmund, 237 Steuben St., Brooklyn, N. Y. (50).

Clark, Ernest P., 58 Broad St., New York, N. Y. (50). 1901. D

Clark, Friend Ebenezer, Ph. D., Dept. of Chemistry, Central Univ., Danville, Ky. (51). C

Clarke, Prof. F. W., U. S. Geol. Survey, Washington, D. C. (18). 1874. C

*Clark, Gaylord Parsons, Professor of Physiology, Syracuse University, Syracuse, N. Y. (50). 1901. F K

*Clark, H. Walton, Bureau of Fisheries, Dept. Commerce and Labor, Washington, D. C. (52). 1906. F

*Clark, Hubert Lyman, Ph. D., Museum of Comparative Zoology, Cambridge, Mass. (50). 1903. F

Clark, James Albert, "The Cumberland," Washington, D. C. (52).

Clark, J. Fred, M. D., Fairfield, Iowa. (50). I K

*Clark, Prof. John E., 34 S. Park Terrace, Long Meadow, Mass. (17).

Clark, John Jesse, Manager, Text Book Dept., International Text Book Co., Scranton, Pa. (50). B D

*Clarke, John Mason, Ph. D., Asst. State Geologist and Palæontologist, State Hall, Albany, N. Y. (45). 1897. E

*Clark, John S., 110 Boylston St., Boston, Mass. (31). 1901. B C I

*Clark, Judson F., Ph. D., 164 Davenport Road, Toronto, Canada (52). 1905. I

*Clarke, Prof. Samuel Fessenden, Williams College, Williamstown, Mass. (50). 1901. F

Clark, Thomas H., Williams College, Williamstown, Mass. (40).

Clark, Vinton Albert, Agriculturist and Horticulturist, Arizona Experiment Station, Phœnix, Arizona. (55) G

Clark, W. A., Ph. D., President State Normal School, Peru, Neb. (52).

Clark, Wm. Brewster, M. D., 50 E. 31st St., New York, N. Y. (33). C F

*Clark, Wm. Bullock, Ph. D., Johns Hopkins University, Baltimore, Md. (37). 1891. E

Claxton, P. P., Dept. of Education, Univ. of Tennessee, Knoxville, Tenn. (52).

*Claypole, Edith J., Ph. D., 50 South Grand Ave., Pasadena, Cal. (46). 1899. F

Cleaver, Albert N., South Bethlehem, Pa. (50). D

*Clements, Frederic Edward, Ph. D., Associate Professor of Botany, Univ. of Nebraska, Lincoln, Neb. (52). 1905. G

Clements, George E., M. D., Crawfordsville, Ind. (52). K

Clements, Joseph, M. D., Nutley, N. J. (52). K

*Clements, J. Morgan, Economic Geologist and Mining Engineer, 15 William St., New York, N. Y. (51). 1903. E

Clerc, Frank L., Hotel Shirley, Denver, Colo. (50). C D

*Clifford, Harry Ellsworth, Mass. Inst. Technology, Boston, Mass (54). 1906.

*Clifton, Richard S, Assistant Secretary A. A. A. S., Washington, D. C. (49). 1906.

Cline, Isaac M., M. D., U. S. Weather Bureau, New Orleans, La. (50). K

*Clinton, George P., Botanist, Conn. Agrl. Ex. Sta., New Haven, Conn. (54). 1906. G

*Cloud, John W., 974 Rookery, Chicago, Ill. (28). 1886. A B D

Clough, Albert L., Box 114, Manchester, N. H. (45). B

Clough, Homer W., Weather Bureau, Washington, D. C. (54). A B

*Coates, Charles E., Ph. D., Louisiana State Univ., Baton Rouge, La. (46). 1906. C

Cobane, Mary Elizabeth, High School, Skaneateles, N. Y. (55) E

*Cobb, Prof. Collier, University of North Carolina, Chapel Hill, N. C. (49). 1905. E

Cobb, N. A., Hawaiian Sugar Planters' Association, Honolulu, T. H. (55). G

Cobey, W. W., U. S. Dept. Agriculture, Washington, D. C. (54). G

Coca, Arthur F., M. D., Wayne, Pa. (54). K

*Cochran, C. B., 514 South High St., West Chester, Pa. (43). 1896. C

*Cockerell, T. D. A., University of Colorado, Boulder, Colo. (50). 1901. F

*Coe, George Albert, Professor of Philosophy, Northwestern University, Evanston, Illinois. (54). 1906. I

Coe, Henry W., M. D., "The Marquam," Portland, Oregon. (32). F H

Coe, Thomas Upham, M. D., Bangor, Maine. (51). K

Coffeen, Hon. H. A., Sheridan, Wyoming. (51).

Coffin, C. A., 44 Broad St., New York, N. Y. (50).

Coffin, Fletcher B., Newton, Mass. (53). C

*Coffin, Rev. Selden J., Ph. D., Lafayette College, Easton, Pa. (22). 1874. A I

*Coghill, George Ellett, Ph. D., Professor of Biology, Pacific Univ., Forest Grove, Oregon. (52). 1903. F G

*Cogswell, Wm. B., Syracuse, N. Y. (33). 1891. D

Cohen, Mendes, Civil Engineer, 825 N. Charles St., Baltimore, Md. (50). D

*Cohen, Solomon Solis, M. D., 1525 Walnut St., Philadelphia, Pa (50). 1903. F K

Coit, John Eliot, College of Agriculture, Cornell University, Ithaca, N. Y. (55). G

Coit, Rev. Dr. Joseph Howland, Rector Saint Paul's School, Concord, N. H. (50).

*Coit, Judson B., Professor of Mathematics and Astronomy, Boston University, Boston, Mass. (54). 1906. A

*Coit, J. Milner, Ph. D., Vice-Rector Saint Paul's School, Concord, N. H. (33). 1903. B C E

*Coker, Wm. Chambers, Ph. D., Associate Professor of Botany, Univ. of North Carolina, Chapel Hill, N. C. (52). 1905. G

*Colburn, Richard T., 120 Broadway, New York, N. Y. (31) 1894. F H I

Colby, Edward A., care Baker Platinum Works, Newark, N. J. (49).

Cole, Aaron Hodgman, 5715 Monroe Ave., Hyde Park, Chicago, Ill. (54). F G

*Cole, Prof. Alfred D., Ohio State Univ., Columbus, Ohio. (39). 1891. B C

Cole, George Watson, Riverside, Con. (52).

Cole, Leon Jacob, 37 Mellen St., Cambridge, Mass. (52). F

Cole, W. F., M. D., Waco, Texas. (51). K

Coleman, Clyde B., 512 S. Matthews St., Urbana, Ill. (54).

Colie, Edw. M., East Orange, N. J. (30). E I

Collett, Samuel Williamson, Principal of High School, Urbana, Ohio. (50). G

*Collier, Arthur James, U. S. Geological Survey, Washington, D. C (52). 1905. E

Collier, Price, Tuxedo Park, N. Y. (50).

*Collin, Prof. Alonzo, Cornell College, Mount Vernon, Iowa. (21). 1891. B C

Collin, Rev. Henry P., Pastor First Presbyterian Church, 58 Division St., Coldwater, Mich. (37). H

*Collingwood, Francis, Elizabeth, N. J. (36). 1888. D

Collins, Guy N., U. S. Department of Agriculture, Washington, D. C. (51). G

Collins, T. Shields, M. D., Globe, Arizona. (51). K

Colton, Geo. H., Professor of Natural Science, Hiram College, Hiram, Ohio. (51). B E

Colton, H. S., 3409 Powellton Ave., Philadelphia, Pa. (54). E

*Colvin, Verplanck, Supt. N. Y. State Adirondack Survey, Albany, N. Y. (28). 1880. E

*Compton, Edith L., Instructor in Dept. Biol. Washington High Schools. 1121 Euclid St., N.W., Washington, D. C. (54). G

*Comstock, Brig.-Genl. C. B., 124 East 27th St., New York, N. Y, (54). 1906.

*Comstock, Prof. Charles Worthington, Civil and Mining Engineer, Boston Bldg., Denver, Colo. (47). 1901. A B

Comstock, Daniel F., 128 Hofstrasse, Zurich, Switzerland. (52). B

*Comstock, Prof. Geo. C., Washburn Observatory, University of Wisconsin, Madison, Wis. (34). 1887. A

*Comstock, John Henry, Professor of Entomology, Cornell University, Ithaca, N. Y. (54). 1906. F

*Comstock, Prof. Theo. B., Mining and Metallurgical Engineer, 534 Stinson Bldg., Los Angeles, Cal. (24). 1877. B D E

Comstock, Dr. T. Griswold, 3401 Washington Ave., St. Louis, Mo. (29). F H

*Conant, Charles A., Treasurer Morton Trust Co., 38 Nassau St., New York, N. Y. (52). 1903. I

Conant, Miss E. Ida, 42 W. 48th St., New York, N. Y. (33). F H I

*Conant, Prof. Levi L., Polytechnic Institute, Worcester, Mass. (39). 1892. A

Conarroe, Thomas H., M. D., 1807 Wallace St., Philadelphia, Pa, (50). F K

Condra, G. E., Ph. D., University of Nebraska, Lincoln, Neb. (54). E

*Conklin, Edwin Grant, Professor of Biology, University of Pennsylvania, Philadelphia, Pa. (50). 1901. F

Connaway, John W., Professor Veterinary Science, Missouri State Univ., Columbia, Mo. (52). F

Connell, John T., Gulfport, Miss. (55). G

Conner, Phineas Sanborn, M. D., 215 W. 9th St., Cincinnati, O. (54). K

Connor, Leartus, M. D., President of Michigan State Medical Society, 103 Cass St., Detroit, Mich. (51). K

Conradi, A. F., State Entomologist, College Station, Texas. (55). F

*Conradson, Pontus H., Chief Chemist, Galena-Signal Oil Co., Franklin, Pa. (51). 1906. B C D

*Converse, Henry Augustus, Instructor in Mathematics, Balto. Polytechnic Inst., 2017 N. Calvert St., Baltimore, Md. (54). 1906. A

*CONVERSE, JOHN H., 500 N. Broad St., Philadelphia, Pa. (54) 1906. D

Converse, Vernon G., care of Ontario Power Co., Niagara Falls, Canada. (50). D

Converse, William A., care Dearborn Drug and Chemical Works, 227 to 234 Postal Telegraph Bldg., Chicago, Ill. (55). C

Cook, Dr. Charles D., 136 Clinton St., Brooklyn, N. Y. (25).

Cooke, George Willis, 49 Park Ave., Wakefield Park, Wakefield, Mass. (47). H I

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*Cook, James B., Ph. D., Randolph Building, Memphis, Tenn. (50).

*Cook, Melville T., Santiago de las Vegas, Cuba. (45). 1902. G

*Cook, Orator F., U. S. Dept. of Agriculture, Washington, D. C. (40). 1892. G

*Cook, Samuel R., Allegheny College, Meadville, Pa. (50). 1903. B C

*Cooley, Grace E., Ph. D., Wellesley College, Wellesley, Mass. (47). 1900. G I

*Cooley, Prof. LeRoy C., Vassar College, Poughkeepsie, N. Y. (19). 1880. B C

*Cooley, Mortimer E., Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich. (33). 1885. D

*Cooley, Robert A., Zoölogist and Entomologist, Montana Agr'l College and Experiment Station, Bozeman, Montana. (50). 1903. F

*Cooper, Hermon Charles, Ph. D., Syracuse Univ., Syracuse, N. Y. (51). 1906. C

Cooper, James Campbell, Room 5, Veale Block, Topeka, Kansas. (50). C E

*Copeland, Edwin Bingham, Bureau of Government Laboratories, Manila, P. I. (45). 1901. G

*Coplin, W. M. L., M. D., Director of Laboratories, Jefferson Medical College Hospital, Philadelphia, Pa. (51). 1903. K

*Coquillett, Daniel William, U. S. National Museum, Washington, D. C. (43). 1902. F

*Corbett, L. C., U. S. Dept. Agriculture, Washington, D. C. (48). 1901. G

Cornelison, Robert W., Sc.D., Manufacturing Chemist, Bloomfield. N. J. (51). C

Cornish, George A., Lindsay, Ont., Canada. (52). F

*Corthell, Elmer L., 1 Nassau St., New York, N. Y. (34). 1886. D E I

Corwin, Clifford Egbert, Teacher of Science, Marietta High School, Marietta, Ohio. (50). C

Cotton, Edwin C., B. Sc., Ohio Department of Agriculture, Columbus, Ohio. (55). F

*Coulter, Prof. John M., University of Chicago, Chicago, Ill. (32). 1884. G

*Coulter, Samuel Monds, Ph. D., The Shaw School of Botany, St. Louis, Mo. (52). 1905. G

*Councilman, Wm. Thomas, Prof. of Pathology, Harvard Medical School, Boston, Mass. (54). 1906. K

Courtis, William Munroe, 412 Hammond Bldg., Detroit, Mich. (46). E C G

Coutant, Richard Bonnet, M. D., Tarrytown, N. Y. (51). K

Covert, Rev. William Ross, McMechen, West Virginia. (53).

*Coville, Frederick V., U. S. Dept. Agriculture, Washington, D. C. (35). 1890. G

Cowart, Fletcher Jackson, Prof. Natural Science, State Normal College, Troy, Ala. (53). F

*Cowles, Alfred H., 656 Prospect St., Cleveland, Ohio. (37). 1897. B C

*Cowles, Edward, M. D., 419 Boylston St., Boston, Mass. (51). 1903. K

*Cowles, H. C., Instructor in Botany Univ. of Chicago, Chicago, Ill. (54). 1906. G

*Cowles, Miss Louise F., Mt. Holyoke College, South Hadley, Mass. (47). 1905. E

Cox, A. Beekman, Civil Engineer, Cherry Valley, N. Y. (50). D

*Cox, Charles F., Grand Central Depot, New York, N. Y. (43). 1900. F G

Cox, Edmund Otis, C. E., 167 East 116th St., New York, N. Y. (51). D

Cox, John L., 1219 Locust St., Philadelphia, Pa. (54).

*Cox, Ulysses O., 433 Washington Ave., Terre Haute, Ind. (50). 1906. F

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Coyle, Rev. John S., S. J., St. Joseph's College, 17th and Stiles Sts., Philadelphia, Pa. (48). **B**

*Crafts, James Mason, Mass. Inst. Technology, Boston, Mass. (47). 1898. **C**

*Cragin, Francis Whittemore, Ph. D., 1715 Wood Ave., Colorado Springs, Colo. (29). 1890. **E F H**

Craig, Alexander Righter, M. D., 232 Cherry Street, Columbia, Pa. (51). **K**

Craig, John, College of Agriculture, Cornell University, Ithaca, N. Y. (41). **G**

Craig, Moses, Agricultural College P. O., Mich. (53). **G**

Craig, Wallace, State Normal School, Valley City, N. Dak. (50). **F H**

*Craighead, E. B., President Tulane University, New Orleans, La. (54). 1906. **G**

*Cram, Roys Jones, 26 Hancock Ave. West, Detroit, Mich. (51). 1906. **F**

Cramer, Gustave, Pres. G. Cramer Dry Plate Co., St. Louis, Mo. (53). **B C**

Cramp, W. M., 1227 N. Broad St., Philadelphia, Pa. (54). **D**

*Crampton, Chas. A., M. D., Office of Internal Revenue Commissioner, U. S. Treasury Dept., Washington, D. C. (36). 1887. **C**

Crampton, C. Ward, M. D., 160 West 119th St., New York, N. Y. (53). **K**

*Crampton, Henry E., Adjunct Professor of Zoology, Barnard College, Columbia University, New York, N. Y. (51). 1903. **F**

*Crandall, Charles S., 1104 W. Oregon St., Urbana, Ill. (40). 1894.

Crandall, Francis Asbury, Librarian of Public Documents, 2219 15th St. N.W., Washington, D. C. (50). **I**

Crane, William I , Superintendent City Schools, Marshalltown, Iowa. (54).

Cranston, Robert E., E. M., Physicians Building, Sacramento, Cal. (50). **D E**

Cratty, R. I., Armstrong, Iowa. (52). **G**

Crawford, David Francis, Genl. Supt. Motive Power, Penna. Lines West of Pittsburg, Union Station, Pittsburg, Pa. (50). **D**

Crawford, J. C., U. S. Dept. Agriculture, Washington, D. C. (54). **F**

*Crawford, Morris B., Middletown, Conn. (30). 1889. **B**

*Crawley, Edwin S., Ph. D., University of Pennsylvania, Philadelphia, Pa. (45). 1900. **A**

Crawley, Howard, Wyncote, Pa. (51). **F**

Crawley, Joseph Sanford, Wyncote, Pa. (54).

Crehore, Albert Cushing, 48 Lincoln Terrace, Yonkers, N. Y. (50). **D E**

*Creighton, J. E., Cornell Univ., Ithaca, N. Y. (54). 1906.
*Crew, Henry, Professor of Physics, Northwestern University, Evanston, Ill. (52). 1903. B
*Crile, George W., M. D., 169 Kensington St., Cleveland, Ohio. (51). 1903. K
Crockard, Frank Hearne, E. M., C. E., Asst. Mgr. Riverside Dept. National Tube Co., Lock Box 34, Wheeling, W. Va. (50). D
*Crocker, Francis B., Professor of Electrical Engineering, Columbia University, New York, N. Y. (50). 1901. B D
*Crockett, Prof. Charles W., Rensselaer Polytechnic Institute, Troy, N. Y. (39). 1894. A D
*Crook, Alja Robinson, Ph. D., Professor of Mineralogy and Economic Geology, Northwestern University, Evanston, Ill. (47). 1902. E
Crosby, Oscar Terry, Cosmos Club, Washington, D. C. (52). C E I
Crosby, Wm. Edward, 1603 Amsterdam Ave., New York, N.Y. (52).
*Crosby, Prof. W. O., Mass. Institute Technology, Boston, Mass. (47). 1900. E
*Cross, Prof. Charles R., Mass. Inst. Technology, Boston, Mass. (29). 1880. B
*Cross, Whitman, U. S. Geological Survey, Washington, D. C. (54). 1906. E
Crouse, Hugh Woodward, M. D., Victoria, Texas. (50). F K
CROWELL, A. F., Woods Holl, Mass. (30). C
*Crowell, John Franklin, care of The Wall Street Journal, New York, N. Y. (50). 1901. I
Crowley, Chas. F., John A. Creighton Medical College, Omaha, Neb. (53). C
*Croxton, Fred. C., U. S. Dept. Commerce and Labor, Washington, D. C. (54). 1906. I
*Crozier, William, Brigadier-General and Chief of Ordnance, U. S. A., War Department, Washington, D. C. (50). 1903. D
Crump, Col. M. H., Bowling Green, Ky. (29). E
Crunden, Frederick Morgan, Librarian Public Library, 3635 Laclede Ave., St. Louis, Mo. (52). I
*Culin, Stewart, Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y. (33). 1890. H
Cullen, Thomas S., M. D., 3 West Preston St., Baltimore, Md. (54). K
*Culver, Garry Eugene, 1103 Main St., Stevens Point, Wis. (54). 1906. C E
*Cumings, Edgar R., Asst. Professor of Geology, Indiana University, Bloomington, Ind. (48). 1901. E
*Cummings, Miss Clara E., Wellesley College, Wellesley, Mass. (47). 1899. G

Cummins, George Wyckoff, M. D., Belvidere, N. J. (50). G K

Cunningham, Francis A., 1613 Wallace St., Philadelphia, Pa. (33). B D E

*Cunningham, Prof. Susan J., Swarthmore College, Swarthmore. Pa. (38). 1901. A

Currie, C. A., M. D., P. O. Box 1606, Philadelphia, Pa. (48). F

*Curtis, Carlton C., Columbia University, New York, N. Y. (51) 1903. G

*Curtis, George Carroll, 64 Crawford St., Boston, Mass. (52). 1905. E

Curtis, G. Lenox, M. D., 7 West 58th St., New York, N. Y. (51).

Curtis, George W., Mgr. Burrus Mill and Elevator Co., Fort Worth. Texas. (50).

Curtis, H. Holbrook, M. D., 118 Madison Ave., New York, N. Y. (51). K

*Curtis, Mattoon M., Prof. of Philosophy, Western Reserve University, Cleveland, Ohio. (50). 1906. H I

Curtiss, C. F., Dean and Director, Iowa State College, Ames, Ia. (54). G

*Curtiss, Richard Sydney, Chemical Laboratory Univ. of Illinois, Urbana. Ill. (52). 1903. C

*Curtis, William E., Post Building, Washington, D. C. (40). 1903. H I

*Curtis, Winterton C., Ph. D., Asst. Prof. of Zoölogy, University of Missouri, Columbia, Mo. (93). 1905. F

*Cushing, Harvey, M. D., 3 West Franklin St., Baltimore, Md., (52). 1906. K

*Cushing, Henry Platt, Adelbert College, Cleveland, Ohio. (33). 1888. E

*Cushman, Allerton, Ph. D., U. S. Dept. Agriculture, Washington, D. C. (50). 1901. C

*Cutler, Elbridge Gerry, M. D., 214 Beacon St., Boston, Mass. (54). 1906. K

Cutter, Ephraim, M. D., 120 Broadway, New York, N. Y. (51). K

Cutter, Irving S., 134 N. 11th St., Lincoln, Neb. (50). F G

*Dabney, Charles W., Ph. D., President University of Cincinnati, Cincinnati, Ohio. (47). 1901. C

*da Costa Sena, Señor Joaquim Candido, Director School of Mines, Ouro Preto, Brazil. (54). 1906. E

Daggette, Alvin S., M. D., 400 South Craig St., Pittsburg, Pa. (50). F K

*Dahlgren, Ulric, Ph. D., Princeton University, Princeton, N. J. (51). 1905. F

Daland, Rev. William Clifton, D. D., President of Milton College, Milton, Wis. (52). I

Dale, J. Y., M. D., P. O. Box 14, Lemont, Pa. (51). K

*Dall, William Healey, Smithsonian Institution, Washington, D. C. (18). 1874. F H

Dalrymple, W. H., Prof. Vet. Science, La. State Univ. and A. & M. College, Baton Rouge, La. (50). F K

*Dana, Dr. Charles L., 50 W. 46th St., New York, N. Y. (46). 1889. H

*Dana, Edward Salisbury, 24 Hillhouse Ave., New Haven, Conn. (23). 1875. B E

Daniel, John, Professor of Physics, Vanderbilt Univ., Nashville, Tenn. (50). B

*Darton, Nelson H., U. S. Geol. Survey, Washington, D. C. (37). 1893.

Daugherty, Rev. Jerome, S. J., President of Georgetown Univ., Washington, D. C. (52).

Daugherty, Lewis S., Professor of Biology, State Normal School, Kirksville, Mo. (53). F

*d'Auria, Luigi, M. E., 12 Cooke St., Providence, R. I. (51). 1903. A D

*Davenport, Charles Benedict, Ph. D., Director Station for Experimental Evolution, Cold Spring Harbor, L. I., N. Y. (46). 1898. F

Davenport, Eugene, Dean of the College of Agriculture, University of Illinois, Champaign, Ill. (39).

Davenport, Francis Henry, M. D., 419 Boylston St., Boston, Mass. (50). K

Davidson, R. J., Agric. Exper. Station, Blacksburg, Va. (40). C

Davies, Arthur Ernest, Ph. D., Ohio State University, Columbus, Ohio. (53). I

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Davis, Abial B., 129 East Lincoln Ave., Mt. Vernon, N. Y. (44). A

*Davis, Andrew McFarland, 10 Appleton St., Cambridge, Mass. (35). 1906. H

*Davis, Bergen, Columbia University, New York, N. Y. (49). 1905. B

*Davis, Bradley Moore, Dept. of Botany, Univ. of Chicago, Chicago, Ill. (45). 1897. G

Davis, Charles Gilbert, M. D., 31 Washington St., Chicago, Ill, (51). K

*Davis, C. H., Rear Admiral, U. S. N., Navy Dept., Washington, D. C. (40). 1896.

Davis, Donald Walton, Assistant in Zoology, Univ. of California Berkeley, Cal. (55). F

Davis, Edward E., 47 W. Main St., Norwich, N. Y. (50).

*Davis, Ellery Williams, Ph. D., Professor of Mathematics, The Univ. of Nebraska Lincoln, Nebr. (55). 1906. A

Davis, George S., P. O. Box 724, Detroit. Mich. (50).
*Davis, Maj-Gen. Geo. W., U. S. A., The Connecticut, Washington, D. C., (54). 1906. D
*Davis, Herman S., Ph. D., Dover, Del. (50). 1901. A
*Davis, J. J., M. D., 1119 College Ave., Racine, Wis. (31). 1899 F G
Davis, Kary Cadmus, Ph. D., Menomonee, Wis. (50). G
*Davis, Nathaniel French, Prof. of Pure Mathematics, Brown University, Providence, R. I. (54). 1906 A
Davis, N. S., Jr., 291 Huron St., Chicago, Ill. (50). F G
*Davis, Wm. Harper, Lehigh University, South Bethlehem, Pa. (50). 1903. H I
*Davis, Prof. W. M., 17 Francis Ave., Cambridge, Mass. (33). 1885. B E
*Davison, Alvin, Ph. D., Lafayette College, Easton, Pa. (49). 1905. F
Davison, John M., Pittsford, N. Y. (38). C
*DAVY, J. BURTT, State Agrostologist and Botanist, Department of Agriculture, Pretoria, Transvaal. (51). 1903. G
*Dawson, Percy Millard, M. D., Instructor in Physiology, Johns Hopkins Medical School, Baltimore, Md. (50). 1903. K
Dawson, William Bell, D. Sc., Marine Department, Ottawa, Canada. (54). D
*DAY, WILLIAM SCOFIELD, Ph. D., 337 W. 87th St., New York, N. Y. (50). 1901. B
*Dean, Arthur Lyman, Ph. D., Yale University, New Haven, Conn. (53). 1906. F
*Dean, Bashford, Columbia University, New York, N. Y. (54). 1906. F
Dean, Seth, C. E., Surveyor of Mills County, Glenwood, Iowa. (34). D
Dean, Wm. H., 167 West River St., Wilkes-Barre, Pa. (50). C
Deans, John Sterling, Chief Engineer, Phoenix Bridge Co. Phoenixville, Pa. (51). D
*Dearborn, George Van Ness, Ph. D., Professor of Physiology, Tufts Medical and Dental Schools, Boston, Mass. (52) 1906. K
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de Geofroy, George, Metropolitan Club, Washington, D. C. (55). C
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De Kalb, Courtenay, Santa Monica and Western Ave., Hollywood, Cal. (54).

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Delafield, Maturin L., Jr., care Morgan, Harjes & Co., Paris, France. (43). G

De Landero, Carlos F., Asst. Director Pachuca and Real del Monte Mining Co., Pachuca, Mexico. (36). B C

*Delano, Frederic A., Supt. of Motive Power, C. B. and Q. Railroad, 209 Adams St., Chicago, Ill. (50). 1906. D

Delany, Patrick Bernard, E. E., Inventor, South Orange, N. J. (50). D

de Lisle, Justin, M. D., 500 Fifth Ave., New York, N. Y. (54). K

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Demming, Henry Clay, Geologist and Mineralogist, Pa. State Bd. of Agriculture, Harrisburg, Pa. (54). E

Dempster, A., 5721 Stanton Ave., Pittsburg, Pa. (50). D

*Dennett, William S., 8 East 49th St., New York, N. Y. (52). 1906. A K

*Dennis, David Worth, Professor of Biology, Earlham College, Richmond, Ind. (50). 1901. F

*Dennis, Louis Munroe, Cornell University, Ithaca, N. Y. (43). 1895. C

Densmore, Emmet, 41st St. and Third Ave., Brooklyn, N. Y. (54). F K

de Raasloff, Harold, Civil Engineer, 18 Burling Slip, New York, N. Y. (51). D

Derby, George McClellan, Major, Corps of Engineers, U. S. A., U. S. Engineers Office, St. Paul, Minn. (50). D

*Derby, Orville A., Commissao Geologica, Sao Paulo, Brazil, South America. (39). 1890. E

Dery, D. George, Catasauqua, Penna. (55). C G

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Detweiler, Andrew J., M. D., State Board of Health, Columbia, Mo. (53). K

Devereux, W. B., 99 John St., New York, N. Y. (50).

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Diemer, Hugo, Associate Professor of Mechanical Engineering, Univ. of Kansas, Lawrence, Kans. (49). **D**

Dietz, William G., M. D., 21 N. Vine St., Hazleton, Pa. (54). **K**

Dike, Archie Clarence, Bristol, Vermont. (54).

*Diller, J. S., U. S. Geological Survey, Washington, D. C. (52). 1903. **E**

*Dimmock, George, Box 1597, Springfield, Mass. (22). 1874. **F**

Dimock, Mrs. Henry F., 25 East 60th St., New York, N. Y. (50).

Dimon, Miss Abigail Camp, 367 Genesee St., Utica, N. Y. (50). **F K**

Dinkey, Alva C., General Supt. Homestead Steel Works, Munhall, Pa. (50). **D**

Disbrow, William S., M. D., 151 Orchard St., Newark, N. J. (51). **K**

Dixon, Brandt B., President of Newcomb College, New Orleans, La. (52). **K**

*Dixon, Roland B., Peabody Museum, Cambridge, Mass. (46). 1901. **H**

*Dixon, Samuel Gibson, M. D., Acad. Nat. Sciences, 1900 Race St., Philadelphia, Pa. (50). 1906. **F K**

Dixson, Prof. Zella Allen, Librarian University of Chicago, Chicago, Ill. (52). **I**

*Dock, George, M. D., Professor of Medicine, University of Michigan, Ann Arbor, Mich. (51). 1903. **K**

*Dodge, Charles Wright, Univ. of Rochester, Rochester, N. Y. (39). 1898. **F**

Dodge, D. Stuart, 6 East 49th St., New York, N. Y. (49).

Dodge, Philip T., Tribune Building, New York, N. Y. (44). **B D**

*Dodge, Richard E., Teachers' College, Columbia Univ., New York, N. Y. (49). 1901. **E I**

Dodman, Alfred C., Jr., 235 W. 108th St., New York, N. Y. (50).

*Dodson, John Milton, Prof. of Medicine and Dean of Students, Rush Medical College, 1109 Venetian Building, Chicago, Ill. (54). 1906. **K**

*Dodson, W. R., Director and Botanist of La. Experiment Station, Baton Rouge, La. (54). 1906. **G**

Doherty, Henry L., 40 Wall St., New York, N. Y. (48). **B C D**

*Dolbear, Prof. A. Emerson, Tufts College, Mass. (20). 1880. **B**

Dole, Rev. Charles Fletcher, Jamaica Plain, Mass. (50). **I**

*Donaldson, Henry Herbert, Professor of Neurology, University of Chicago, Chicago, Ill. (54). 1906. **K**

Donovan, Cornelius, Assistant Engineer, U. S. Engineer Office, Custom House, New Orleans, La. (51). **D**

*Doolittle, Prof. C. L., Upper Darby, Pa. (25). 1885. **A**

Doran, Edwin W., James Milliken Univ., Decatur, Ill. (54). **F**

*Dorsey, George A., Ph. D., Field Columbian Museum, Chicago, Ill. (39). 1892. **H**

Dorsey, Herbert Grove, 129 Dryden Road, Ithaca, N. Y. (51). **B**

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Doty, Paul, care St. Paul Gas Light Co., St. Paul, Minn. (43). **D**

Doubt, Thomas Eaton, Ph. D., Armour Inst. of Technology, Chicago, Ill. 1898. (48). **B**

Doughty, Mrs. Alla, Milford, Pa. (49).

DOUGHTY, JOHN W., 165 Johnston St., Newburgh, N. Y. (19). **E**

Douglas, Edward Morehouse, U. S. Geological Survey, Washington, D. C. (54). **E**

Douglas, Mrs. George William, Tuxedo Park, N. Y. (49).

*Douglas, James, 99 John St., New York, N. Y. (49). 1905. **E**

Douglas, Orlando B., 20 Pleasant St., Concord, N. H. (49).

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Dow, Herbert H., Midland, Mich. (47). **C**

*Dowd, Jerome, Lecturer on Sociology, Wisconsin University, Madison, Wis. (55). 1906. **I**

Dowell, Philip, Ph. D., 12 Bond St., Port Richmond, N. Y. (50). **F**

Downing, Elliott Rowland, Ph. D., Professor of Biology, Northern State Normal School, Marquette, Mich. (51). **F**

Downs, Edgar Selah, Ph. D., 111 Broadway, New York, N. Y. (50). **B**

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Dozier, Melville, Professor of Mathematics and Physical Sciences, State Normal School, Los Angeles, Cal. (53). **A B**

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Drayer, Howard C., Yeatman High School, St. Louis, Mo. (51).

Drescher, Willibald A. E., P. O. Drawer 1033, Rochester, N. Y. (41). **F**

*Drew, Gilman A., Prof. of Zoölogy, Univ. of Maine, Orono, Me. (54). 1906. **F**

Drinker, Henry Sturgis, Ph. D., President of Lehigh University, South Bethlehem, Pa. (55). **D I**

*Droppers, Garrett, President of the State University, Vermillion, S. Dak. (50). 1901. **I**

Drummond, Isaac Wyman, Ph. D., 436 W. 22d St., New York, N. Y. (36).

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Duane, Alexander, M. D., 49 East 30th St., New York, N. Y. (54). **K**

*Duane, William, Ph. D., Professor of Physics, State University, Boulder, Colo. (50). 1901. **B**

*Du Bois, Prof. Aug. J., New Haven, Conn. (30). 1882. **A B D**

*Du Bois, Howard Weidner, 4526 Regent St., Philadelphia, Pa. (47). 1906. **A**

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*Du Bois, W. E. Burghardt, Professor of Economics and History, Atlanta University, Atlanta, Ga. (50). 1905. **I**

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*Dudley, Charles B., Drawer 156, Altoona, Pa. (23). 1882. **B C D**

Dudley, S. W., Box 512, Kelly Ave., Wilkinsburg, Pa. (50). **A D**

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*Dudley, Prof. Wm. R., Dept. of Systematic Botany, Stanford University, Cal. (29). 1883. **G**

*Duerden, J. E., Ph. D., Professor of Zoology, Rhodes University College, Grahamstown, S. Africa. (52). 1905. **F**

Dugan, Raymond S., Ph. D., Instructor in Astronomy, Princeton University, Princeton, N. J. (55). **A**

*Duggar, Benjamin Minge, Professor of Botany, Univ. of Missouri, Columbia, Mo. (45). 1900. **G**

*Duke, Frank Williamson, Professor of Mathematics, Hollins Institute, Hollins, Va. (50). 1906. **A**

Dulles, Charles W., M. D., 4101 Walnut St., Philadelphia, Pa. (51). **K**

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Duncan, Fred. N., Professor of Chemistry, Emory College, Oxford, Ga. (50). **C**

*Duncan, George Martin, Professor of Philosophy, Yale University, New Haven, Conn. (50). 1902. **H**

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Dunham, Henry Bristol, M. D., State Sanatorium, Rutland, Mass. (51). K

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Dunlevy, Robert Baldwin, Southwest Kansas College, Winfield, Kansas. (50). C E

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*Duvall, Trumbull Gillette, Ph. D., Professor of Psychology and Philosophy, Ohio Wesleyan University, Delaware, Ohio. (52). 1906. H

*Duvel, Joseph W. T., U. S. Dept. of Agriculture, Washington, D. C. (48). 1905. G

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*Earle, F. S., Estacion Central Agronomica, Santiago de las Vegas Cuba. (39). 1896. G

Earle, Samuel Broadus, Professor of Mechanical Engineering, Clemson College, S. C. (54). D

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*Eastman, Charles Rochester, Museum Comp. Zoology, Cambridge, Mass. (41). 1896. E F

*Eastman, Prof. J. R., Andover, N. H. (26). 1879. A

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*Eastwood, Miss Alice, Curator of Herbarium, California Academy of Sciences, San Francisco, Cal. (50). 1901. G

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*Eaton, George Francis, 80 Sachem St., New Haven, Conn. (54). 1906. F

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Eccles, David Charles, Northwestern Univ., Evanston, Ill. (50). C

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*Eckel, Edwin C., U. S. Geological Survey, Washington, D. C. (51). 1906. E

Eckles, Clarence Henry, Univ. of Missouri, Columbia, Mo. (50) F

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*Edwards, Col. Clarence R., U. S. A., Chief of the Bureau of Insular Affairs, War Department, Washington, D. C. (52). 1906. I

Egbert, J. Hobart, M. D., Surgeon U. S. Coast and Geodetic Survey, Washington, D. C. (55). K

Ehrenfeld, Charles Hatch, Prof. Chemistry and Physics, Collegiate Institute, York, Pa. (54). C

Ehrenfeld, Frederick, Ph. D., Instructor in Geology, University of Pennsylvania, Philadelphia, Pa. (50). E

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*Eiesland, John, Ph. D., Instructor U. S. Naval Academy, Annapolis, Md. (50). 1903. A
*Eigenmann, Carl H., Ph. D., Indiana University, Bloomington, Ind. (48). 1899. F
Eikenberry, William Lewis, Instructor in Botany, High School, St. Louis, Mo. (53). G
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*Elkin, William L., Yale University Observatory, New Haven, Conn. (33). 1885. A
Elliot, George T., M. D., 36 East 35th St., New York, N. Y. (50). F K
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*Ellis, Frederick W., M. D., Monson, Mass. (47). 1906. B H
Ellis, Henry Rives, 217 S. West Temple St., Salt Lake City, Utah. (53). C
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*Elrod, Morton John, Professor of Biology, University of Montana, Missoula, Mont. (50). 1901. F
Ely, Charles Russell, Professor of Natural Science, Gallaudet College, 5 Kendall Green, Washington, D. C. (52). C
Ely, Sumner Boyer, 5122 Dahlia St., Pittsburg, Pa. (50). D
*Ely, Theo. N., Chief of Motive Power, Pennsylvania R.R., Broad St. Station, Philadelphia, Pa. (29). 1886. D
*Emerson, Prof. Benjamin K., Box 203, Amherst, Mass. (19). 1877. E F
*Emerson, C. F., Box 499, Hanover, N. H. (22). 1874. A B
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Emery, Albert Hamilton, Jr., 312 Main St., Stamford, Conn. (47). D
Emery, William O., Crawfordsville, Ind. (53). C
Emmons, Arthur B., Newport, R. I. (50). E
*Emmons, S. F., U. S. Geol. Survey, Washington, D. C. (26). 1879. E

Emory, Hon. Frederic, Queenstown, Md. (52). I

Enders, Howard Edwin, Johns Hopkins Univ., Baltimore, Md. (50). F G

Engle, Horace M., Roanoke, Va. (52). E

*Engler, Edmund Arthur, President Worcester Polytechnic Institute, Worcester, Mass. (50). 1901. A

English, William Thompson, M. D., Professor of Physical Diagnosis, Western University of Pennsylvania, Pittsburg, Pa. (50). K

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Erwin, A. T., Associate Prof. of Horticulture, Iowa State College, Ames, Ia. (54). G

Eshner, Augustus A., M. D., Prof. of Clinical Medicine, Phila. Polytechnic, 1019 Spruce St., Philadelphia, Pa. (54). K

Essary, Samuel Henry, Asst. in Botany, Univ. of Tenn., Knoxville, Tenn. (54). G

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ESTES, DANA, Brookline, Mass. (29). H I

Eustis, Allan Chotard, M. D., Instructor in Chemistry, Medical Department, Tulane University, New Orleans, La. (55). C K

*Evans, Alexander W., M. D., 12 High St., New Haven, Conn. (45). 1903. G

Evans, Britton D., M. D., Medical Director of N. J. State Hospital, Morris Plains, N. J. (51). K

*Evans, Henry Brown, College Hall, Univ. of Penna., Philadelphia, Pa. (48). 1906. A

Evans, Illbyd Buller Pole, Dept. Agriculture, Pretoria, Transvaal. (55). G

Evans, Samuel G., 211 Main St., Evansville, Ind. (39). F

*Evans, Thomas, University of Cincinnati, Cincinnati, Ohio. (53). 1906. C

*Evans, Walter Harrison, Ph. D., Department of Agriculture, Washington, D. C. (52). 1906. G

Eveland, Arthur John, Bureau of Science, Department of the Interior, Manila, P. I. (55). E

*Evermann, Barton Warren, Bureau of Fisheries, Department of Commerce and Labor, Washington, D. C. (52). 1905. F

Evers, Edward, M. D., 1861 N. Market St., St. Louis, Mo. (28). F H

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Faber, John, M. D., 289 Central Ave., Jersey City, N. J. (54). H K

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Fairchild, B. T., P. O. Box 1120, New York, N. Y. (36).
*Fairchild, David Grandison, U. S. Dept. Agriculture, Washington, D. C. (47). 1898. G
*Fairchild, Prof. H. L., Univ. of Rochester, Rochester, N. Y. (28). 1883. E F
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Farabee, William Curtis, Ph. D., Instructor in Anthropology, Harvard Univ., Peabody Museum, Cambridge, Mass. (54). H
*Fargis, Rev. Geo. A., S. J., Georgetown University, Washington, D. C. (40). 1892.
Farley, Godfrey Pearson, C. E., General Manager, W. W. & F. R. R. Co., Wiscasset, Maine. (51). D
*Farlow, Dr. W. G., 24 Quincy St., Cambridge, Mass. (20). 1875. G
Farnham, Amos W., State Normal School, Oswego, N. Y. (54). E
Farnsworth, Philo J., M. D., Clinton, Iowa. (50). K
*Farquhar, Henry. Census Office, Washington, D. C. (33). 1886. A B G I
Farr, Marcus S., Sc. D., Princeton Univ., Princeton, N. J. (49). E
*Farrand, Livingston, M. D., Columbia University, New York, N. Y. (50). 1902. H
Farwell, Elmer S., Consulting Engineer, 309 Broadway, New York, N. Y. (51). A D
Farwell, Robert Benneson, C. E., 53 Monument Ave., Charlestown, Mass. (47). D
*Fassig, Oliver Lanard, Johns Hopkins University, Baltimore, Md. (46). 1899. B
Fast, Richard Ellsworth, Professor American History and Political Sciences, West Virginia University, Morgantown, W. Va. (50). I
Faught, John B., Professor of Mathematics, Northern State Normal School, Marquette, Mich. (50). A
Faull, Mrs. Annie B. Sargent, 22 Boswell Ave., Toronto, Canada. (52). F
Faull, Joseph Horace, Lecturer in Botany, Univ. of Toronto, Toronto, Canada. (54). G
Fawcett, Ezra, Mechanical and Electrical Engineer, 233 Ely St. Alliance, Ohio. (48). B D
Fawcett, William, Director, Dept. of Public Gardens and Plantations, Hope Gardens, Kingston, Jamaica, B. W. I. (53). G

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Fellows, Charles S., 912 Chamber of Commerce, Minneapolis, Minn. (34). F

*Felt, Ephraim Porter, Ph. D., State Entomologist, Albany, N. Y. (44). 1899. F

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Fenner, Robert Coyner, Instructor in Physics, Cornell University, 531 E. State St., Ithaca, N. Y. (54). B

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*Ferguson, Alexander McGowen, Instructor in Botany, Univ. of Texas, Austin, Texas. (51). 1905. G

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*Ferguson, Margaret C., Assoc. Prof. of Botany, Wellesley College, Wellesley, Mass. (54). 1906. G

*Fernow, Bernhard E., Ithaca, N. Y. (31). 1887. G I

Ferry, Dexter M., Jr., Seedsman, 1040 Woodward Ave., Detroit, Mich. (50). G

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*Fewkes, Dr. J. Walter, Bureau of Amer. Ethnology, Washington, D. C. (48). 1900. H

Field, George Wilton, Mass. Inst. Tech., Boston, Mass. (47).

Field, Herbert Haviland, Ph. D., Director Concilium Bibliographicum, Zürich, Neumünster Eidmattstrasse 38, Zürich, Switzerland. (54). F

Field, W. L. W., Milton, Mass. (47). F

Finch, John Wellington, State Geologist, Jacobson Bldg., Denver, Colo. (50). E

Findlay, Merlin C., Professor of Biology, Park College, Parkville, Mo. (50). F

*Fink, Prof. Bruce, Professor of Botany, Iowa College, Grinnell, Iowa. (45). 1890. G

Finley, Norval Howard, 7229 Hermitage St., East Liberty Station, Pittsburg, Pa. (52). C

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Fisch, Dr. Carl, 3212 Pine St., St. Louis, Mo. (53). K

Fischer, Charles E. M., care of Western Electric Co., 477 Rice St., Chicago, Ill. (53). F

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Fish, Charles Henry, M. E., General Manager, Cocheco Mf'g Co. Dover, N. H. (51). D

*Fish, Pierre A., D. Sc., Professor of Comparative Physiology and Pharmacology, Cornell University, Ithaca, N. Y. (49). 1901. K

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Fisher, Cassius Asa, Assistant Geologist, U. S. Geological Survey, Washington, D. C. (55). E

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Fisher, George E., 37 and 39 Wall St., New York, N. Y. (37).

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Fisher, Henry Wright, 5403 Friendship Ave., Pittsburg, Pa. (51). D

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Fiske, Wilbur A., Professor of Science, Richmond High School, Richmond, Ind. (51). B

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*Fitz Gerald, Francis A. J., P. O. Box 118, Niagara Falls, N. Y. (50). 1906. C

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Fitz-Randolph, Raymond Bernard, Director State Laboratory of Hygiene, Trenton, N. J. (54). C K

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*Fletcher, Robert, M. D., Army Medical Museum, Washington, D. C. (29). 1881. F H

*Fletcher, Robert, Ph. D., Director of Thayer School of Civil Engineering, Hanover, N. H. (51). 1902. D

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Fox, Philip, Carnegie Assistant, Yerkes Observatory, Williams Bay, Wis. (53). A
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Foxworthy, Fred. William, Bureau of Science, Manila, P. I. (52). G
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*Fuller, Prof. Homer T., Fredonia, N. Y. (35). 1891. C E
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Grover, Edwin Osgood, General Editor for Rand, McNally and Co., Highland Park, Ill. (52).
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Guth, Morris S., M. D., Supt. State Hospital for the Insane, Warren, Pa. (51). K
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Hamilton, S. Harbert, 4806 Fairmount Ave., Philadelphia, Pa. (54). C E H

Hammatt, Clarence Sherman, Vice-President, Florida Electric Co. Jacksonville, Fla. (50). D

Hammel, Wm. C. A., Director of Manual Training and Physics, State Normal College, Greensboro, N. C. (50). B F

*Hammer, William Joseph, Consulting Electrical Engineer, 1406 Havemeyer Building, New York, N. Y. (52). 1906. B

Hammond, George W., Yarmouthville, Maine. (47).

*Hammond, John Hays, 71 Broadway, New York, N. Y. (50). 1901. D E

HAMMOND, MRS. JOHN HAYS, 320 Madison Ave., Lakewood, N. J. (50). H

*HANAMAN, C. E., Troy, N. Y. (19). 1883. F

Hance, Anthony M., 2217 DeLancey Place, Philadelphia, Pa. (51). C

Hancock, Charles, Prof. of Civil Engineering and Drawing, Agricultural College, Miss. (55). A

*Hancock, Harris, Prof. of Mathematics, Univ. of Cincinnati, Cincinnati, O. (54). 1906. A

Hancock, James Cole, M. D., 43 Cambridge Place, Brooklyn, N. Y. (51). K

Hanger, G. Wallace W., Chief Clerk Bureau of Labor, Washington, D. C. (54). I

Hankinson, Thomas L., Assistant in Biology, State Normal School, Charleston, Ill. (53). F

Hanks, M. W., 216 Langdon St., Madison, Wis. (54).

Hanna, Meredith, Room 602, Crozer Bdg., Philadelphia, Pa. (54). C

Hard, Jas. M. B.. Cordobanes 16, City of Mexico, Mexico. (50). C

*Harding, Everhart Percy, Instructor in Chemistry, University of Minnesota, Minneapolis, Minn. (50). 1901. C

*Harding, Harry A., N.Y. Agricultural Experiment Station, Geneva, N. Y. (48). 1906. G

*Hargitt, Prof. Charles W., Syracuse University, Syracuse, N. Y. (38). 1891. F

Harmon, Herbert W., South-Western State Normal School, California, Pa. (52). B

Harnly, Henry Jacob, Ph. D., Professor of Biology, McPherson College, McPherson, Kan. (50). F G

*Harper, Henry Winston, M. D., 2208 San Antonio St., Austin, Texas. (45). 1899. C

*Harper, R. A., 324 N. Carroll St., Madison, Wis. (54). 1906. G

Harper, R. H., M. D., Afton, Indian Ter. (51). F H K

Harper, Roland McMillan, Ph. D., University, Ala. (55). E G

Harrah, C. J., P. O. Box 1606, Philadelphia, Pa. (48). H

Harriman, George B., 59 Lawrence Ave., Roxbury, Mass. (52). K

*Harris, Abram Winegardner, Sc. D., Port Deposit, Md. (40). 1895. C

*Harris, Prof. Elijah P., Amherst College, Amherst, Mass. (44). 1896.

Harris, Frederick S., 1717 Railway Exchange, Chicago, Ill. (50). E

HARRIS, J. CAMPBELL, 119 So. 16th St., Philadelphia, Pa. (51).

Harris, James Arthur, Mo. Botanical Garden, St. Louis, Mo. (52). F G

*Harris, Norman MacLeod, Instructor in Bacteriology, Univ. of Chicago, Chicago, Ill. (54). 1906. K

Harris, Robert Wayne, M. D., 621 Vincennes St., New Albany, Ind. (51). K

*Harris, Rollin Arthur, U. S. C. and G. Survey, Washington, D. C. (47). 1899. A

*Harris, Uriah R., Captain U. S. N., U. S. Navy Yard, Boston, Mass. (34) 1886. A

Harris, William Denny, 3609 Ludlow St., Philadelphia, Pa. (54). B C D

*Harrison, Ross G., Ph. D., Johns Hopkins University, Baltimore, Md. (54). 1906. F

*Harshberger, John W., Instructor in Botany, Univ. of Pa., Philadelphia, Pa. (54). 1906. G

*Hart, Charles A., Assistant to State Entomologist, Univ. of Illinois, Urbana, Ill. (51). 1906. F

*Hart, Edw., Ph. D., Lafayette College, Easton, Pa. (33). 1885. C

*Hart, James Norris, Professor of Mathematics and Astronomy, Univ. of Maine, Orono, Maine. (51). 1906. A

*Hart, Joseph Hall, Ph. D., Instructor in Physics, Randal Morgan Laboratory, Univ. of Penn., Philadelphia, Pa. (52). 1906. B

Hart, Rev. Prof. Samuel, Berkeley Divinity School, Middletown, Conn. (22). **A**

Harter, Leonard L., B. A., U. S. Dept. of Agriculture, Washington, D. C. (55). **G**

Hartgering, James, Rapid City, S. Dak. (52). **C D**

Hartley, Chas. P., Assistant in Plant Breeding, Bureau of Plant Industry, Dept. Agriculture, Washington, D. C. (51). **G**

Hartley, Frank, Principal of Allegheny County Academy, Cumberland, Md. (51). **E G**

Hartline, D. S., State Normal School, Bloomsburg, Pa. (54). **F**

Hartman, Dr. C. V., Curator of Archæology and Ethnology, Carnegie Museum, Pittsburg, Pa. (53). **H**

Hartmann-Kempf, Dr. Robert, Frankfort A. M., Germany. (54). **B**

Hartness, James, President of Jones and Lamson Machine Co., Springfield, Vt. (51). **D**

Hartwell, Burt Laws, R. I. Agr. Exp. Station, Kingston, R. I. (55) **C**

Hartz, J. D. Aug., College Point, N. Y. (43).

Hartzell, J. Culver, Ph. D., Univ. of the Pacific, San José, Cal. (49). **E**

Harvey, Le Roy Harris, Prof. of Biology, Yankton College, Yankton, S. D. (54). **G**

Harvey, Nathan Albert, Ph. D., 223 Summit St., Ypsilanti, Mich. (52). **F**

Harvey, Wm. Stocker, 119 So. 4th St., Philadelphia, Pa. (47).

Hasie, Montague S., C. E., Texas Bridge Co., Dallas, Texas. (51). **D**

*Haskell, Eugene E., U. S. Lake Survey, Detroit, Mich. (39). 1896. **A B D**

*Haskell, Mellen Woodman, Associate Professor of Mathematics, Univ. of California, Berkeley, Cal. (54). 1906. **A**

Haslam, George J., M. D., Fremont, Neb. (54). **F K**

Hasslacher, Jacob, 100 William St., New York, N. Y. (50).

*Hastings, C. S., Sheffield Scientific School, Yale University, New Haven, Conn. (25). 1878. **B**

Hastings, Edwin George, Asst. Bacteriologist, Agr. Exp. Station, Madison, Wis. (50). **F**

Hastings, John Walter, 6 Hastings Hall, Harvard Univ., Cambridge, Mass. (54). **H**

Hastings, William Walter, 287 Hickory St., Springfield, Mass. (54).

*Haupt, Gen. Lewis Muhlenberg, C. E., Consulting Engineer, 107 North 35th St., Philadelphia, Pa. (51). 1903. **D**

Havemeyer, W. F., 32 Nassau St., New York, N. Y. (50).

Hawkins, J. Dawson, Colorado Springs, Colo. (50). **C D**

Hawxhurst, Robert, Jr., C. E., 620 North C St., Tacoma, Wash. (53) **D**

*Hay, Prof. Oliver Perry, Amer. Mus. Nat. History, Central Park, New York, N. Y. (49). 1901. **F**

Hay, Prof. William P., Howard Univ., Washington, D. C. (49).
*Hayes, C. Willard, U. S. Geological Survey, Washington, D. C. (51). 1905. E
*Hayes, Ellen, Professor of Applied Mathematics, Wellesley College. Wellesley, Mass. (52). 1905. A
Hayes, George Washington, C. E., Prof. of Chemistry, Pennsylvania Chautauqua, Lebanon, Pa. (51). C D
Hayes, Joel Addison, Banker, Colorado Springs, Colo. (51).
Hayes, Noah, M. D., Seneca, Nemaha Co., Kansas. (51). K
*Hayford, John F., C. E., U. S. C. and G. Survey, Washington, D. C. (46). 1898. A B D
Haynes, Prof. Arthur E., College of Engineering, University of Minnesota, Minneapolis, Minn. (45).
Haynes, Miss Caroline C., 16 East 36th St., New York, N. Y. (52).
*Haynes, Prof. Henry W., 239 Beacon St., Boston, Mass. (28). 1884. H
Haynes, Miss Julia Anna, 614 S. Burdick St., Kalamazoo, Mich. (47). F G
Hays, B. Frank, Secy. Fraser Tablet Co., 758 West End Ave., New York, N. Y. (49).
*Hays, Willet M., Asst. Secy. Dept. Agriculture, Washington, D. C. (45). 1901. G I
Haywood, Prof. John, Otterbein University, Westerville, Ohio. (30). A B
Hazard, Daniel L., U. S. C. and G. Survey, Washington, D. C. (18).
*Hazard, Hon. Rowland G., Peace Dale, R. I. (50). 1906.
*Hazen, Tracy Elliott, Barnard College, Columbia University, New York, N. Y. (50). 1902. G
Head, William R., 5471 Jefferson Ave., Hyde Park, Chicago, Ill. (38). F
Headlee, T. J., Forest Home, N. Y. (52). F
*Heald, Fred. DeForest, Ph. D., Adjunct Professor of Plant Physiology, University of Nebraska, Lincoln, Neb. (50). 1903. F
Healy, Daniel J., M. D., Army Medical Museum, Washington, D. C. (54). K
Hearn, Rev. David William, President College of St. Francis Xavier, 30 West 16th St., New York, N. Y. (52). I
Hearne, William W., 1625 Real Estate Trust Bldg., Philadelphia, Pa. (54).
Heath, Harry E., care Gen'l Electric Co., Lynn, Mass. (50). D
Heaton, Augustus George, 1618 17th St., N.W., Washington, D. C. (52).
Hebbard, Ellery Cola, M. D., 122 Huntington Ave., Boston, Mass. (51). K
Hebden, Edwin, Principal of Group A, Public Schools, Baltimore Md. (50). E

*Hedgcock, George Grant, Mo. Botanical Garden, St. Louis, Mo. (50). 1903. G

Hedge, Frederic H., 440 Boylston St., Brookline, Mass. (28). F H

*Hedrick, Henry B., Nautical Almanac Office, U. S. Naval Observatory, Washington, D. C. (40). 1896. A

Hefferan, Miss Mary, Univ. of Chicago, Chicago, Ill. (52). F

*Heilprin, Angelo, Academy Natural Sciences, Philadelphia, Pa. (52). 1905. E

Heisler, Chas. L., M. E., 211 N. Ash St., St. Mary's, Ohio. (51). D

*Hektoen, Ludvig, Professor of Pathology, University of Chicago, Chicago, Ill. (52). 1906. K

Hellick, Chauncey Graham, Ph. D., Dept. Electrical Engineering, Lafayette College, Easton, Pa. (50).

*Hemmeter, John C., M. D., Prof. of Physiology, Univ. of Maryland, 1734 Linden Ave., Baltimore, Md. (51). 1906. K

*Henchman, Miss Annie Parker, 8 Frisbie Place, Cambridge, Mass. (54). 1906. F

Henderson, Joseph J., 689 10th St., Brooklyn, N. Y. (51).

*Henderson, Junius, Curator of the Museum, Univ. of Colorado, Boulder, Colo. (50). 1906. F

*Henderson, William Edward, Ph. D., Associate Prof. Chemistry, Ohio State University, Columbus, Ohio. (50). 1901. C

Henius, Max, Ph. D., 294 South Water St., Chicago, Ill. (52). K

*Henmon, V. A. C., Columbia Univ., New York, N. Y. (54). 1906. K

Hennen, Ray Vernon, C. E., L. B. 448, Morgantown, W. Va. (50). D

Henrich, Carl, Mining Engineer, Metasville, Ga. (50). A E I

*Henry, Alfred J., Professor of Meteorology, U. S. Weather Bureau, Washington, D. C. (49). 1901. B

Henry, Charles C., M. D., 56 Clark St., Brooklyn, N. Y. (43).

Henry, Stewart L., 908 S. Carrollton Ave., Station B., New Orleans, La. (55).

Hensel, Samuel Theodore, P. O. Box 14, Capital Hill Station, Denver, Colo. (50). C G

Henshaw, Henry W., Biological Survey, Dept. of Agriculture, Washington, D. C. (55). F H

Henzey, Sam'l Alexander, Glen Ridge, N. J. (51).

Herbert, Arthur P., Engineer and Supt. Colima Division, Compania Constructora Nacional Mexicana, Colima, Colima, Mex. (51). D

*Hering, Daniel Webster, Professor of Physics, New York University, University Heights, New York, N. Y. (50). 1906. B D

*Hering, Rudolph, 170 Broadway, New York, N. Y. (33). 1885. D E I

Herr, Hiero B., Civil and Mining Engineer, Summit, N. J. (50). **E**

*Herrick, C. Judson, Denison University, Granville, Ohio. (49). 1901. **F**

*Herrick, Francis Hobart, Professor Biology, Adelbert College, Cleveland, Ohio. (52). 1905. **F**

Herrick, Glenn W., Professor of Biology, A. and M. College, Agricultural College, Miss. (50). **F**

HERRMAN, MRS. ESTHER, 59 West 56th St., New York, N. Y.

*Herrmann, Richard, Sec'y Iowa Institute of Science and Arts, Dubuque, Iowa. (50). 1902. **C E**

Herron, William Harrison, U. S. Geological Survey, Washington, D. C. (52). **D E I**

*Herter, Christian A., M. D., 819 Madison Ave., New York, N. Y. (50). 1902. **K**

*Herty, Charles Holmes, Ph. D., University of North Carolina, Chapel Hill, N. C. (42). 1895. **C**

*Hervey, Rev. A. B., Bath, Me. (22). 1879. **F**

Herzog, Felix Benedict, Ph. D., President Herzog Teleseme Co., 51 West 24th St., New York, N. Y. (50). **D**

Herzstein, M., M. D., 801 Sutter St., San Francisco, Cal. (52). **K**

Hess, Selmar, Publisher, 956 Madison Ave., New York, N. Y. (53). **I**

Hesse, Conrad E., U. S. Weather Bureau, Washington, D. C. (50). **A**

Hessler, Robert, M. D., Logansport, Ind. (54). **F K**

Heston, John W., President South Dakota Agricultural College, Brookings, S. D. (50). **I**

Hewett, Edgar L., U. S. National Museum, Washington, D. C. (50). **H**

HEXAMER, C. JOHN, C. E., 419 Walnut St., Philadelphia, Pa. (33). **B C**

Heyer, Wm. D., 523 South Broad St., Elizabeth, N. J. (33). **B D**

Heyl, Paul Renno, Instructor in Physics, Central High School, Philadelphia, Pa. (54). **B**

Hibbard, Rufus P., Univ. of Mich., Ann Arbor, Mich. (54).

*Hice, Richard R., Beaver, Pa. (51). 1906. **E**

Hichborn, C. S., Secretary State Survey Commission, Augusta, Me. (52). **I**

Higdon, John Clark, 605 Missouri Trust Bldg., St. Louis, Mo. (50). **B D I**

*Higdon, John E., 3939 Charles Ave., Indianapolis, Ind. (54). 1906. **A B D K**

Higgins, Lafayette, C. E., Prof. of Chemistry, West D. M. High School, Des Moines, Iowa. (51). **C**

Higginson, James J., 16 E. 41st St., New York, N. Y. (49).

Higley, Hon. Warren, 68 West 40th St., New York, N. Y. (43).

*Hilgard, Prof. E. W., Univ. of California, Berkeley, Cal. (11). 1874. **B C E**

Hill, Ebenezer, Treasurer, Norwalk Iron Works, South Norwalk, Conn. (50). **D**

*Hill, Eben Charles, Johns Hopkins University, Baltimore, Md. (54). 1906. **K**

Hill, Edwin A., Assistant Examiner, U. S. Patent Office, Washington, D. C. (52). **D**

*Hill, George A., U. S. Naval Observatory, Washington, D. C. (47). 1900. **A**

*Hill, John Edward, Prof. of Civil Engineering, Brown University, Providence, R. I. (44). 1897. **D**

*Hill, Robert Thomas, Trinity Bldg., New York, N. Y. (36). 1889. **E**

Hill, Wm. K., Carthage College, Carthage, Ill. (54). **G**

*Hillebrand, William F., U. S. Geological Survey, Washington, D. C. (51). 1903. **E**

Hillig, Frederick J., S. J., St. Johns College, Toledo, Ohio. (50). **B**

Hillkowitz, Wm., M. D., 704 Race St., Cincinnati, Ohio. (50). **C F I K**

*Hillyer, Homer W., Ph. D., Chemical Laboratory, Univ. of Wisconsin, Madison, Wis. (42). 1896. **C**

Hillyer, William Eldridge, care S. and P. Telephone Co., 722 12th St., N.W., Washington, D. C. (52).

*Hilprecht, Prof. H. V., 1932 Locust St., Philadelphia, Pa. (54). 1906.

*Hilton, William A., 435 Penn. Ave., Waverly, N. Y. (49). 1906. **F**

*Himes, Prof. Charles F., Carlisle, Pa. (29). 1882. **B C**

*Himowich, Adolph A., M. D., 130 Henry St., New York, N. Y. (52). 1906. **K**

Hinds, J. I. D., Ph. D., University of Nashville, Nashville, Tenn. (55). **C**

*Hinds, W. E., U. S. Dept. of Agriculture, Washington, D. C. (54). 1906. **F**

Hindshaw, Henry Havelock, Assistant in Geology, State Museum, Albany, N. Y. (52). **E**

*Hine, James S., Ohio State Univ., Columbus, Ohio. (48). 1903. **F**

Hinman, Edgar Linderson, Assoc. Prof. of Philosophy, Univ. of Nebraska, Lincoln, Nebr. (54). **F**

*Hinrichs, Dr. Gustavus, 4106 Shenandoah Ave., St. Louis, Mo. (17). 1874. **B C**

Hinsdale, Wilbert B., M. D., Univ. of Michigan, Ann Arbor, Mich. (54). **K**

Hirschfelder, Jos. Oakland, M. D., Professor of Cl. Med., Cooper Medical College, 1392 Geary St., San Francisco, Cal. (51). **K**

Hirshfeld, Clarence Floyd, Asst. Prof. Steam Engineering, Cornell University, Ithaca, N. Y. (54).

*Hiss, P. Hanson, M. D., 437 West 59th St., New York, N. Y. (49). 1903. **K**

*Hitchcock, Albert Spear, Div. Agrostology, U. S. Dept. Agriculture, Washington, D. C. (39). 1892. **G**

Hitchcock, Miss Caroline Judson, Teacher in High School, Meriden, Conn. (50). **B E**

*Hitchcock, Charles H., LL.D., Hanover, N. H. (11). 1874. **E**

Hitchcock, Miss Fanny R. M., 4038 Walnut St., Philadelphia, Pa. (35). 1906. **F**

*Hitchcock, Frank H., First Assistant Postmaster-General, Washington, D. C. (49). 1901. **I**

Hitchcock, George Collier, 709 Wainwright Bldg., St. Louis, Mo. (53). **I**

*Hitchcock, Romyn, Room 1804, 20 Broad St., New York, N. Y. (47). 1898. **B C**

Hitz, John, Supt. of Volta Bureau, 1601–3 Thirty-fifth St., Washington, D. C. (52).

Hoad, W. C., Assistant Professor Civil Engineering, Univ. of Kansas, Lawrence, Kans. (54). **D**

*Hoadley, George A., Swarthmore College, Swarthmore, Pa. (40). 1900. **B**

Hoagland, Henry Williamson, M. D., 327 N. Nevada Ave., Colorado Springs, Colo. (51). **F K**

Hoagland, Ralph, Asst. in Chem. Agriculture, Agr. Exp. Sta., St. Anthony Park, Minn. (53). **C**

Hobbs, Prof. Perry L., Western Reserve Medical College, Cleveland, Ohio. (41). **C**

*Hobbs, William Herbert, Ph. D., Madison, Wis. (41). 1893. **E**

Hobby, C. M., M. D., Iowa City, Iowa. (51). **K**

Hobson, Richmond Pearson, Greensboro, Ala. (54).

Hodge, Frederick Humbert, Instructor in Mathematics, Clark University, Worcester, Mass. (50). **A**

*Hodge, Frederick Webb, Smithsonian Institution, Washington, D. C. 1903. (52).

Hodge, James M., Big Stone Gap, Va. (29). **D E**

Hodges, Robert Shattuck, Chemist Ala. Geological Survey, University, Ala. (54). **C E**

*Hodgkins, Prof. H. L., George Washington University, Washington, D. C. (40). 1896. **A B**

Hodgkins, William Candler, Coast and Geodetic Survey, Washington, D. C. (52). **D**

Hodgson, Richard, 15 Charles St., Boston, Mass. (54). **H I K**

Hoe, Mrs. R., Jr., 11 E. 36th St., New York, N. Y. (36).

Hoe, Mrs. Richard M., 11 E. 71st St., New York, N. Y. (36).

Hoffman, Frank Sargent, Professor of Philosophy, Union University, Schenectady, N. Y. (52). 1906. **H**

*HOFFMANN, DR. FRIEDRICH, Charlottenburg, Kant St. 125 Berlin, Germany. (28). 1881. C F

*Hoffman, Samuel V., Morristown, N. J. (52). 1906. A D

Hogan, Edgar Poe, Professor of Chemistry and Biology, Howard College, East Lake, Ala. (54). C F

Hogan, Mrs. Louise E., 438 West 116th St., New York, N. Y. (52).

Hogeboom, Miss Ellen C., Principal of Ashland Seminary, Versailles, Ky. (46). C

Holbrook, Percy, Genl. Mgr. Weber Ry. Joint Mfg. Co., 2528 Broadway, New York, N. Y. (51). D

Holden, Edwin R., 13 E. 79th St., New York, N. Y. (49).

HOLDEN, MRS. L. E., The Hollenden, Cleveland, Ohio. (35).

*Holferty, George M., Ph. D., Instructor in Botany, Central High School, St. Louis, Mo. (50). 1905. G

*Holland, W. J., D. D., LL. D., Director Carnegie Institute, Pittsburg, Pa. (57). 1896. F

*Hollick, Arthur, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (31). 1892. E G

Hollinshead, Warren H., Vanderbilt University, Nashville, Tenn. (37).

Hollister, J. James, care Providence Consolidated Gold Mining Co., Carters, Cal. (51). E

Holman, Richard Morris, Assistant in Botany, Stanford University, Palo Alto, California. (55). G

Holmes, A. M., M. D., Jackson Block, Denver, Colo. (50). F K

*Holmes, Prof. Joseph A., State Geologist, Chapel Hill, N. C. (33). 1887. E F

Holmes, Miss Mary S., 1331 N. Twelfth St., Philadelphia, Pa. (50). E

*Holmes, S. J., Ph. D., University of Wisconsin, Madison, Wis. (51). 1903. F

*Holmes, Wm. H., U. S. National Museum, Washington, D. C. (30). 1883. H

Holstein, George Wolf, Hamby, Texas. (28). E H

Holt, Erastus Eugene, M. D., 723 Congress St., Portland, Me. (54). K

Holt, Henry, 29 W. 23d St., New York, N. Y. (29).

Holton, Henry D., M. D., Brattleboro, Vt. (44). I

Holzinger, John M., 207 West King St., Winona, Minn. (54). G

Homburg, Frederick, Teacher of Chemistry, Woodward High School, Cincinnati, Ohio. (51). C

Homer, Charles S., Valentine & Co., 257 Broadway, New York, N. Y. (29).

*Hood, Ozni P., Professor of Mechanical and Electrical Engineering, School of Mines, Houghton, Mich. (52). 1906. D

Hood, William, 512 Van Ness Ave., San Francisco, Cal. (35). D

Hooker, Davenport, 211 Durfee Hall, Yale University, New Haven, Conn. (52). F

Hooker, Donald R., Chemist, 1707 Fairmont Ave., Baltimore, Md. (50). C K

Hooker, Henrietta E., Ph. D., Professor of Botany, Mt. Holyoke College, South Hadley, Mass. (45). **G**

Hooker, John D., 325 West Adams St., Los Angeles, Cal. (51). **A**

Hooker, William A., U. S. Dept. of Agriculture, Washington, D. C. (54). **F**

Hooper, Prof. Franklin W., Curator Brooklyn Institute, Brooklyn, N. Y. (43).

Hoopes, H. E., Media, Pa. (52). **H**

Hoose, James H., Ph. D., Professor of Philosophy, Univ. of Southern California, Los Angeles, Cal. (52). **I**

Hoover, Herbert C., 39 Hyde Park Gate, London, S. W. England. (51). **E**

Hoover, Mrs. Lou Henry, 39 Hyde Park Gate, London, S. W., England. (51). **E**

Hoover, William, Athens, Ohio. (49).

Hopeman, H., M. D., Minden, Neb. (51). **K**

Hopkins, Albert Lloyd, 2904 West Ave., Newport News, Va. (51).

Hopkins, Anderson Hoyt, Librarian Carnegie Library, Pittsburg, Pa. (52).

*Hopkins, A. D., Ph. D., U. S. Department Agriculture, Washington, D. C. (42). 1899. **F**

*Hopkins, Prof. Arthur John, Amherst College, Amherst, Mass. (44). 1900. **C**

Hopkins, George B., 52 Broadway, New York, N. Y. (50).

*Hopkins, Grant S., Cornell University, Ithaca, N. Y. (41). 1900. **F**

*Hopkins, Nevil Monroe, Asst. Professor of Chemistry, George Washington University, Washington, D. C. (48). 1901. **C D**

Hopkins, Rupert Henry, College Ave., Westerleigh, West New Brighton, N. Y. (54). **C**

Hopkins, Samuel A., M. D., 235 Marlboro St., Boston, Mass. (54). **K**

*Hopkins, Thomas Cramer, Syracuse University, Syracuse, N. Y. (38). 1898. **E**

Hormell, Prof. William G., Ohio Wesleyan Univ., Delaware, Ohio. (48). **B**

Hornung, Christian, Professor of Mathematics and Astronomy, Heidelberg University, Tiffin, Ohio. (50). **A D**

*Horsford, Miss Cornelia, 27 Craigie St., Cambridge, Mass. (46). 1897. **H**

Horton, Byron Barnes, Sheffield, Pa. (54). **F G**

*Hortvet, Julius, State Chemist, Old Capitol, St. Paul, Minn. (50). 1906. **C**

*Hoskins, Leander Miller, Professor of Applied Mathematics, Stanford University, Cal. (54). 1906. **A**

*Hoskins, William, La Grange, Ill. (34). 1903. **C**

Hosmer, Sidney, E. E., Boston Electric Light Co., 3 Head Place, Boston, Mass. (50). **D**

Hotchkiss, Elmer Aro, President Champaign County Board of School Examiners, Mechanicsburg, Ohio. (52). **B**

Hotchkiss, H. Stuart, 55 Hillhouse Ave., New Haven, Conn. (50). **E I**

*Hotchkiss, Homer J., Professor of Physics, Drexel Institute, 5044 Cedar Ave., Philadelphia, Pa. (54). 1906. **B**

Hottes, Charles Frederick, Asst. Prof. of Botany, Univ. of Illinois, Urbana, Ill. (54). **G**

*Hough, Prof. G. W., Northwestern University, Evanston, Ill. (15). 1874. **A B D**

*Hough, Theodore, Ph. D., Simmons College, Boston, Mass. (51). 1903. **K**

*Hough, Walter, U. S. National Museum, Washington, D. C (38). 1890.

*Houghton, E. Mark, 130 Longfellow Ave., Detroit, Mich. (52). 1906. **K**

Houghton, Frederick, Public School, No. 7, Buffalo, N. Y. (51). **H**

Houk, Mrs. Eliza P. T., Cherry Angle, Dayton, Ohio. (48).

*Houser, Gilbert L., Ph. D., Professor Animal Morphology, University of Iowa, Iowa City, Iowa. (50). 1906. **F K**

*Hovey, Edmund O., Amer. Mus. Nat. History, Central Park, New York, N. Y. (36). 1895. **C E**

*Hovey, Rev. Horace C., 60 High St., Newburyport, Mass. (29). 1883. **E H**

Howard, Charles P., 116 Farmington Ave., Hartford, Conn. (51).

*Howard, Prof. Curtis C., 97 Jefferson Ave., Columbus, Ohio. (38). 1892.

Howard, Harry Turner, 3513 St. Charles Ave., New Orleans, La. (55).

Howard, Kenneth Samuel, Treas. Rochester Academy of Science, 402 Wilder Bldg., Rochester, N. Y. (55). **C E**

*Howard, Leland O., Ph. D., Cosmos Club, Washington, D. C. (37). 1889. **F**

Howard, Mrs. Leland O., 2026 Hillyer Place, N.W., Washington, D. C. (49). **H**

Howard, Orson, M. D., Curator of Museum, University of Utah, Salt Lake City, Utah. (50). **F K**

*Howard, S. Francis, Asst. Professor of Chemistry, Mass. Agricultural College, Amherst, Mass. (50). 1901. **C**

Howard, Wm. Lee, M. D., 1126 N. Calvert St., Baltimore, Md. (51). **K**

*Howard, William Travis, Jr., Prof. of Pathology, Western Reserve University, Cleveland, O. (54). 1906. **K**

*Howe, Charles S., President Case School of Applied Science, Cleveland, Ohio. (34). 1891. **A**

*Howe, Ernest, Ph. D., U. S. Geological Survey, Washington, D. C. (52). 1906. E

Howe, Freeland, Jr., Norway, Maine. (53). F G

*Howe, Henry M., Professor of Metallurgy, Columbia University, New York, N. Y. (50). 1901. D

*Howe, Herbert Alonzo, Director of the Chamberlin Observatory, University of Denver, University Park, Colo. (50). 1901. A

*Howe, Prof. Jas. Lewis, Washington and Lee University, Lexington, Va. (36). 1888. C

Howe, J. Morgan, M. D., 12 West 46th St., New York, N. Y. (50).

*Howe, Marshall A., New York Botanical Garden, Bronx Park, New York, N. Y. (49). 1903. G

Howe, Reginald Heber, Jr., Middlesex School, Concord, Mass. (54). F G

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Howell, John W., Ballantine Parkway, Newark, N. J. (50).

*Howell, William H., M. D., Professor of Physiology, Johns Hopkins University, Baltimore, Md. (50). 1901. F K

Howell, Wilson Stout, Sec'y Association of Edison Illuminating Companies, 80th St. and East End Ave., New York, N. Y. (50). D

Hower, Harry Sloan, Instructor in Physics, Case School of Applied Science, Cleveland, Ohio. (50). B

Howison, George Holmes, LL. D., Mills Professor ofPhilosophy, Univ. of California, Berkeley, Calif. (54). A

Howland, Howard Newell, 5451 Drexel Ave., Chicago, Ill. (50). F

Howland, Randolph H., 130 Grove St., Montclair, N. J. (54). F

*Hoxton, Llewellyn Griffith, Johns Hopkins University,Baltimore, Md. (54). 1906. B

Hoyt, Adrian Hazen, M. D., Manager Whitney Electric Co., Penacook, N. H. (52). D

Hoyt, Olive Sawyer, Kobe College, Kobe, Japan. (52). C

*Hrdlicka, Alës, M. D., U. S. National Museum, Washington, D. C. (46). 1897. H

Hubbard, George David, Asst. Prof. Geology, Ohio State Univ., Columbus, O. (55). E

Hubbard, Walter C., Coffee Exchange Bldg., New York, N. Y. (49).

*Huber, G. Carl, M. D., Professor of Histology and Embryology and Director of Histological Laboratory, University of Michigan, Ann Arbor, Mich. (50). 1901. F K

Hubley, G. Wilbur, Electric Light Co., Louisville, Ky. (52). D

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Hughes, Charles Hamilton, M. D., President, Barnes Medical College, 3857 Olive St., St. Louis, Mo. (53). K

Hulbert, C. E., Secretary, Department of Anthropology, La. Purchase Exposition, St. Louis, Mo. (53). H

*Hull, Gordon Ferrie, Professor of Physics, Dartmouth College, Hanover, N. H. (50). 1903. B

Hume, Alfred, C. E., University, Miss. (39). A

Hummel, John A., Experiment Station, St. Anthony Park, Minn. (48).

Humphrey, Henry Baker, Palo Alto, Cal. (55). G

*Humphrey, Richar L., Testing Laboratory, City Hall, Philadelphia, Pa. (48). 1992. D

Humphreys, Alex. C., M. E., C. E., 31 Nassau St., New York, N. Y. (49).

Humphreys, David Carlisle, C. E., Professor of Civil Engineering. Washington and Lee University, Lexington, Va. (53). D

*Humphreys, W. J., Mount Weather, Bluemont, Va. (54). 1906. A

Hunt, Arthur E., Teacher of Biology Manual Training High School, Brooklyn, N. Y. (54). F

Hunt, Caroline L., In charge Department Home Economics, Univ. of Wisconsin, Madison, Wis. (54). C

Hunt, Chas. Wallace, Stapleton, N. Y. (51).

*Hunter, Andrew Frederick, Barrie, Ontario, Can. (38). 1896. B H I

Hunter, George William, 2238 Andrews Ave., University Heights, New York, N. Y. (52). F

*Hunter, Prof. J. Rufus, Richmond College, Richmond, Va. (45). 1899. C

*Hunter, Samuel John, Associate Professor of Entomology, University of Kansas, Lawrence, Kansas. (50). 1902. F

*Hunter, Walter David, U. S. Department Agriculture, Washington, D. C. (50). 1905. F

Huntington, Ellsworth, Highland St., Milton, Mass. (51).

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Huntoon, Louis Doremus, Asst. Prof. Mining and Metallurgy, Sheffield Scientific School, Yale Univ., New Haven, Conn. (55). D

Hurd, E. O., Plainville, Ohio. (30). E F

Hurst, Julius H. M. D., Box 192, Madison, Conn. (52). K

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Hyde, Charles Gilman, Asst. Prof. Sanitary Engineering, Univ. of California, Berkeley, Calif. (47). **D**

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Hyde, E. Francis, 36 W. 58th St., New York, N. Y. (43). **A**

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Hyde, Frederick E., Jr., 20 W. 53d St., New York, N. Y. (43). **H**

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Iden, Thomas M., Professor of Chemistry and Physics, State Normal School, Emporia, Kansas. (50). **B C F**

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Ingham, Wm. A., 320 Walnut St., Philadelphia, Pa. (33). **E**

Ingram, Edward Lovering, C. E., Expert Aid, New York Navy Yard, New York, N. Y. (51). **A B C D**

Iorns, Martin J., Mount Vernon, Ia. (50). **C G**

*Irving, John Duer, South Bethlehem Pa. (51). 1903. **E**

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*Jack, John G., Jamaica Plain, Mass. (31). 1890. **G**

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*Jackson, Abraham Wendell, 432 St. Nicholas Ave., New York, N. Y. (54). 1906. **E**

*Jackson, Prof. Charles L., Harvard University, Cambridge, Mass. (44). 1895. **C**

Jackson, John H., M. D., 155 Franklin St., Fall River, Mass. (51). **K**

Jackson, Dr. Robert T., 9 Fayerweather St., Cambridge, Mass. (37). 1890. **F**

Jackson, Victor H., M. D., D. D. S., 240 Lenox Ave., New York, N. Y. (51). **K**

Jacobs, Henry Barton, M. D., Instructor in Medicine, Johns Hopkins Medical School, Baltimore, Md. (50). **K**

*Jacobs, J. Warren, 404 So. Washington St., Waynesburg, Pa. (54) 1906. F

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*Jacobus, David S., Stevens Institute, Hoboken, N. J. (36). 1889. A B D

*Jacoby, Harold, Columbia University, New York, N. Y. (38). 1891. A

*Jacoby, Henry S., Professor of Bridge Engineering, Cornell University, Ithaca, N. Y. (36). 1892. D

Jaffa, Myer Edward, Berkeley, Cal. (47).

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*James, William, Professor of Philosophy, Harvard University, Cambridge, Mass. (52). 1903. I

*Jaques, Capt. William H., Little Boar's Head, New Hampshire. (47). 1899. D

Jarman, Joseph L., President and Prof. of Chemistry, State Female Normal School, Farmville, Va. (51). C

*Jastrow, Dr. Joseph, Univ. of Wisconsin, Madison, Wis. (35). 1887. F H

Jayne, Harry W., 931 N. Broad St., Philadelphia, Pa. (54). C

*Jayne, Horace, 318 S. 19th St., Philadelphia, Pa. (29). 1884. F H

Jefferis, Wm. W., 474 Central Park, West, New York, N. Y. (33). E

Jefferson, J. P., Manufacturer, Warren, Pa. (51). D I

*Jefferson, Mark S. W., Professor of Geology, State Normal College, Ypsilanti, Mich. (52). 1906. E

*Jeffrey, Edward Charles, Ph. D., 12 Avon Place., Cambridge, Mass. (52). 1905. G

Jeffrey, Robert Henry, Apartado 104, Oaxaca, Mexico. (53). G

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Jelly, George Frederick, M. D., 69 Newbury St., Boston, Mass. (50). F K

*Jenkins, Edw. H., Agricultural Station, New Haven, Conn. (33). 1885. C

Jenkins, J. F., M. D., 48 Chicago St., Tecumseh, Mich. (51). K

*Jenkins, Oliver Peebles, Professor of Physiology, Stanford University, Cal. (52). 1905. F K

*Jenks, Albert E., Elroy, Wis. (50). 1902. H

*Jenks, Elisha T., Middleboro, Mass. (22). 1874. D

Jenks, Wm. H., Brookville, Pa. (38).

Jenks, William Johnson, Electrical Engineer, 120 Broadway, New York, N. Y. (50). **B D**

*Jenney, Walter Proctor, E. M., Ph. D., Consulting Geologist and Mining Engineer, Knutsford Hotel, Salt Lake City, Utah. (50). 1903. **E**

*Jennings, Gainor, M. D., West Milton, Ohio. (51). **K**

*Jennings, H. S., Biological Hall, Univ. of Pennsylvania, Philadelphia, Pa. (54). 1906. **F**

Jennings, Otto Emery, Carnegie Museum Annex, 419 Craft Ave., Pittsburg, Pa. (53). **G**

*Jennings, Walter L., Worcester Polytechnic Institute, Worcester, Mass. (45). 1898.

Jensen, Chas. A., U. S. Department of Agriculture, Washington, D. C. (54). **C**

Jessen, Karl Detlev, Ph. D., Bryn Mawr College, Bryn Mawr, Pa. (55). **H**

*Jesup, Morris K., 44 Pine St., New York, N. Y. (29). 1891. **I**

*Jewell, Lewis E., Johns Hopkins University, Baltimore, Md. (49). 1906. **A**

*Jewett, Prof. Frank Fanning, Oberlin College, Oberlin, Ohio. (47). 1899. **C**

Jewett, Geo. Franklin, M. D., Britton, S. Dak. (51). **K**

Jewett, William Cornell, C. E., 541 Ridgeway Ave., Avondale, Cincinnati, Ohio. (52). **D**

Job, Robert, Chemist P. & R. Ry., 109 Windsor St., Reading, Pa. (54). **C**

*Joffe, S. A., Mutual Life Insurance Co., of N. Y., 55 Cedar St., New York, N. Y. (54). 1906. **A**

Johannsen, Albert, Ph. D., U. S. Geological Survey, Washington, D. C. (54). **E**

Johannsen, Oskar Augustus, Asst. Prof. Civil Engineering, Cornell Univ., Ithaca, N. Y. (54). **D**

Johns, Carl, Professor of Natural History, Bethany College, Lindsborg, Kans. (50). **F**

Johnson, Alba B., Rosemont, Pa. (54).

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Johnson, Chas. Willison, Boston Society of Natural History, Boston, Mass. (51).

Johnson, Douglas Wilson, Instructor in Geology Mass Inst. of Technology, Boston, Mass. (54). **E**

*Johnson, Duncan S., Ph. D., Associate Professor of Botany, Johns Hopkins University, Baltimore, Md. (54). 1906. **G**

Johnson, Frank Seward, M. D., 2521 Prairie Ave., Chicago, Ill. (51). **K**

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Johnson, John W., Prof. of Physics, Univ. of Mississippi, University, Miss. (55). B

*Johnson, Otis C., 730 Thayer St., Ann Arbor, Mich. (34). 1886. C

Johnson, Thomas Carskadon, Asst. Horticulturist, West Virginia Agr. Exp. Sta., Morgantown, West Virginia. (51). G

*Johnson, Willis Grant, 52 Lafayette Place, New York, N. Y. (47). 1901. F

Johnson, W. Smythe, Ph. D., Univ. of Arkansas, Fayetteville, Ark. (49). H

Johnston, Geo. Ben., M. D., 407 E. Grace St., Richmond, Va. (51). K

*Johnston, John Black, Professor of Zoology, Univ. of West Va., Morgantown, W. Va. (52). 1903. F

Johnston, Col. Thomas Alexander, Supt. Kemper Military School, Boonville, Mo. (55).

Johnston, Thomas J., 66 Broadway, New York, N. Y. (50). A B D

Johnston, William A., Prince Bay, Borough of Richmond, N. Y. (50). C

*Johonnott, Edwin Sheldon, Ph. D., Associate Professor of Physics, Rose Polytechnic Institute, Terre Haute, Ind. (50). 1903. B

*Jones, Adam Leroy, Ph. D., Princeton Univ., Princeton, N. J. (52). 1905. H I

Jones, Arthur Taber, Instructor in Physics, Purdue University, La Fayette, Ind. (53). B

Jones, Charles R., U. S. Dept. Agriculture, Washington, D. C (55). F

Jones, Clement Ross, Professor Mechanical Engineering, West Virginia University, Morgantown, W. Va. (50). D

*Jones, Frederick S., Professor of Physics, University of Minnesota, Minneapolis, Minn. (45). 1901. B

Jones, Grinnell, Harvard University, Cambridge, Mass. (52). C

*Jones, Lewis Ralph, Professor of Botany, University of Vermont, Burlington, Vt. (41). 1894. G

*Jones, Lynds, M. Sc., Instructor in Zoology, Oberlin College, Oberlin, Ohio. (50). 1905. F

*Jones, Prof. Marcus E., Salt Lake City, Utah. (40). 1893. G

Jones, Richard Watson, LL. D., Prof. Chemistry, Univ. of Mississippi, University, Miss. (55). C

Jones, William H., 723 W. Main St., Decatur, Ill. (54).
*Jordan, Prof. David Starr, President of Stanford University, Stanford University, Cal. (31). 1883. F
*Jordan, Edwin Oakes, Ph. D., University of Chicago, Chicago, Ill. (50). 1901. K
*Jordan, Whitman H., Director N. Y. Agric. Exper. Station Geneva, N. Y. (45). 1902. I
Juat, Francis, M. D., Florala, Ala. (50). F K
*Judd, Dr. Charles H., Yale University, New Haven, Conn. (49). 1901. H I
*Julien, Alexis A., Columbia University, New York, N. Y. (24). 1875. C E
Jungblut, Herman C., M. D., Tripoli, Iowa. (52). K
Just, Jno. A., Chemist, 915 W. Genesee St., Syracuse, N. Y. (50). C
Kaadt, Peter S., M. D., Clinton, Ia. (54). K
Kahl, Hugo, Carnegie Museum, Pittsburg, Pa. (50). F
*Kahlenberg, Louis, Ph. D., Professor of Physical Chemistry, Univ. of Wisconsin, Madison, Wis. (46). 1898. C
Kahn, Julius, 100 West 80th St., New York, N. Y. (50). C
Kammerer, Jacob Andrae, 87 Jameson Ave., Toronto, Canada. (50). C D
*Kane, Elisha Kent, Kushequa, Pa. (54). 1906. D
Kane, Thos. F., Ph. D., President University of Washington, Seattle, Wash. (55).
Kann, Myer M., Station B, Pittsburg, Pa. (51).
*Kasner, Edward, Ph. D., Tutor in Mathematics, Barnard College, Columbia University, New York, N. Y. (52). 1903. A
Kauffman, William Albert, 73 Hooker Ave., Poughkeepsie., N Y. (52).
Kay, James I., 426 Diamond St., Pittsburg, Pa. (51). D I
Kean, Mrs. Hamilton Fish, 25 East 37th St., New York, N. Y. (50).
*Keane, John J., Rt. Rev., Archbishop of Dubuque, Dubuque, Ia. (51). 1906.
Kearfott, W. D., Montclair, N. J. (54). F
*Kearney, Thomas H., U. S. Dept. Agriculture, Washington, D. C, (47). 1902. G
*Keasbey, Lindley Miller, Professor of Economics and Politics, Bryn Mawr College, Bryn Mawr, Pa. (51). 1903. H I
*Keep, Wm. J., 753 Jefferson Ave., Detroit, Mich. (37). 1897.
Keilholtz, Pierre Otis, Consulting Engineer, Continental Trust Building, Baltimore, Md. (50). D
Keim, Edward Tudor, E. E., Supt. Am. Dist. Tel. Co., 1421 Champa St., Denver, Colo. (50). D E F

Keith, John Meiggs, Manager Costa Rica Div. United Fruit Co., San José, Costa Rica, C. A. (54). G

*Keith, Miss Marcia A., Lake Erie College, Painesville, Ohio. (46). 1906. B

*Keller, Edward, Ph. D., Box 724, Baltimore, Md. (50). 1903. C D

Keller, Emil E., P. O. Box 452, Pittsburg, Pa. (51).

*Kellerman, William A., Ph. D., Ohio State University, Columbus, Ohio. (41). 1893. G

Kelley, Walter S., Mining Engineer, 1393 Golden Gate Ave., San Francisco, Cal. (50). D

Kellogg, John H., M. D., Battle Creek, Mich. (24). F

*Kellogg, Vernon Lyman, Professor of Entomology, Stanford University, California. (50). 1901. F

Kelley, Edward O. G., Urbana, Ill. (55). F

Kelly, John F., Ph. D., Consulting Electrical Engineer, 284 W. Housatonic St., Pittsfield, Mass. (50). D

Kelly, William, Mining Engineer, General Manager Penn. Iron Mining Co., Vulcan, Mich. (50). D E

Kelsey, James A. Dunlop, Iowa. (49).

*Kemp, George T., Professor of Physiology, University of Illinois, Champaign, Ill. (52). 1906. K

*Kemp, James F., School of Mines, Columbia University, New York, N. Y. (36). 1888. F

Kempton, Charles Walter, Mining Engineer, 29 Broadway, New York, N. Y. (54). E

*Kendall, Arthur I., Ph. D., care of Canal Hospital, Panama, P. R. (52). 1906. F

Kendall, Hugh F., Mining Engineer, Carlson Exploration Co, Hibbing, Minn. (50). E

*Kendall, William Converse, Bureau of Fisheries, U. S. Department of Commerce and Labor, Washington, D. C. (52). 1906. F

*Kendrick, Arthur, Electrical Measuring Instruments, 45 Hunnewell Ave., Newton, Mass. (45). 1897. B

Kennedy, Frank Lowell, Instructor in Lawrence Scientific School, Harvard University, Cambridge, Mass. (50.)

Kennedy, George Golding, M. D., Readville, Mass. (40). F G

KENNEDY, HARRIS, 284 Warren St., Roxbury, Mass. (40). E F

Kennedy, Mary E., Teacher of Botany, Maryville College, Maryville, Tenn. (54). G

*Kennelly, Arthur Edwin, Sc. D., Professor Electrical Engineering, Harvard University, Cambridge, Mass. (50). 1901. B D

Kent, James Martin, Instructor in Steam and Electricity, Manual Training High School, Kansas City, Mo. (50). D E

*Kent, Norton Adams, Ph. D., Professor Physics, Wabash College. Crawfordsville, Ind. (50). 1906. A

*Kent, William, Professor of Mechanical Engineering, Syracuse University, Syracuse, N. Y. (26). 1881. D I

Kenyon, Oscar Curtis, Teacher of Physics, High School, Syracuse, N. Y. (50). B

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*Kerr, William Jasper, D. Sc., President of Agricultural College of Utah, Logan, Utah. (52). 1906. A

*Kershner, Prof. Jefferson E., Lancaster, Pa. (29). 1883. A B

Kesler, John Louis, Department of Biology, Baylor University, Waco, Texas. (51). F

*Kester, Fred. Edward, Ohio State University, Columbus, Ohio. (48). 1906. B

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Kimball, Albert B., M. E., Central High School, Springfield, Mass. (47). B

*Kimball, Arthur Lalanne, Professor of Physics, Amherst College, Amherst, Mass. (50). 1901. B

Kimball, Edwin Boyce, Mining Engineer, Oroville, Cal. (50). D

Kimball, James H., Observer U. S. Weather Bureau, Richmond, Va. (51). A B

Kimball, S. I., Life Saving Service, U. S. Treasury Dept., Washington, D. C. (49). I

Kindle, Edward M., Ph. D., Geologist, 109 Elm St., New Haven, Conn. (50). E

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King, George B., Lawrence, Mass. (47).
King, Helen Dean, Ph. D., Box 93, Bryn Mawr, Pa. (54). F
*King, Theo. Ingalls, U. S. Naval Observatory, Washington, D. C. (52). 1906. A
King, W. F., Chief Astronomer, Dept. Interior, Ottawa, Canada. (55). A
*Kingsbury, Albert, 219 Stratford Ave., Pittsburg, Pa. (43). 1898. D
*Kingsbury, Benj. F., Stimson Hall, Cornell University, Ithaca, N. Y. (45). 1899. F
*Kingsley, J. Sterling, Tufts College, Mass. (52). 1903. F
Kinner, Hugo, M. D., 1103 Rutger St., St. Louis, Mo. (21). F H
Kinney, Charles Noyes, Professor of Chemistry, Drake University, Des Moines, Iowa. (50). C
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Kinraid, Thomas Burton, 38 Spring Park Avenue, Jamaica Plain, Mass. (47).
Kinsler, John H., Dept. of Agriculture, Washington, D. C. (52). G
*Kinsley, Carl, Quadrangle Club, Chicago, Ill. (47). 1903. B
*Kinyoun, J. J., M. D., Glenolden, Pa. (51). 1903. K
Kirby, Gustavus T., 2 Wall St., New York, N. Y. (54). B D
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*Kirkpatrick, E. A., State Normal School, Fitchburg, Mass. (49). 1905. H I
Kirkpatrick, Samuel, M. D., 915 Alabama St., Selma, Ala. (51). K
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*Kirschmann, A., Ph. D., Toronto University, Toronto, Can. (50). 1901. H K
Kittredge, Miss H. A., 56 Prospect St., North Andover, Mass. (37). F
Klebs, Arnold C., M. D., 706, 100 State St., Chicago, Ill. (51). K
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*Klotz, Otto Julius, 437 Albert St., Ottawa, Can. (38). 1889.

Knab, Frederick, U. S. National Museum, Washington, D. C. (53). F
Knapp, Alfred A., M. D., Brimfield, Ill. (51). K
Knapp, G. N., College of Agriculture, Madison, Wis. (46). G H
*Knapp, Hon. Martin A., Chairman of the Interstate Commerce Commission, Washington, D. C. (52). 1903. I
Knapp, S. A., Ph. D., U. S. Dept. Agriculture, Washington, D. C. (54). G
Knauff, Francis Henry, Oak Lane, Philadelphia, Pa. (51). D
Knerr, Ellsworth B., Sc. D., Midland College, Atchison, Kas. (51).
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Knight, Wm. H., President So. California Academy of Sciences, 2 Bryson Block, Los Angeles, Cal. (51). A
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Knox, Francis H., Electrical Engineer, 814 Lewis Bldg., Pittsburg, Pa. (50). D
Knox, Geo. Platt, Principal Yeatman High School, Garrison Ave., or Palm St., St. Louis, Mo., (53).
Knox, Rev. George Wm., Prof. of Philosophy, Union Theological Seminary, New York, N. Y. (55). C
Knox, Henry H., Mining Engineer, 82 Beaver St., New York, N. Y. (50). D
*Kober, Geo. Martin, M. D., 1600 T St., N.W., Washington, D. C. (40). 1896. H
*Koch, Waldemar, Ph. D., Assistant Professor of Physiological Chemistry and Pharmacology, University of Missouri, Columbia, Mo. (53). 1906. C
*Kofoid, Prof. Charles Atwood, University of California, Berkeley, Cal. (48). 1899. F
Kolbenheyer, Fred'k, M. D., 2006 Lafayette Ave., St. Louis, Mo. (51). K
Kortright, Frederic L., Assoc. Prof. Chemistry, Box 325, Morgantown, W. Va. (55). C
Koues, Miss Elizabeth L., 282 W. 85th St., New York, N. Y. (41). I
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Krause, Otto H., Prospect Ave., Hackensack, N. J. (50).
Krécsy, Prof. Béla, VI Bulyovsxky u. 26, Budapest, Hungary. (41). C

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Kretz, Walter C., 137 E. Hanover St., Trenton, N. J. (54). A D

Kribs, Herbert Guy, 300 Highland Ave., Chestnut Hill, Philadelphia, Pa. (53). F

*Kroeber, A. L., Ph. D., Affiliated Colleges, San Francisco, Cal. (47). 1901. H

Kuh, Sydney, M. D., Columbus Memorial Bldg., 103 State St., Chicago, Ill. (54). H K

Kuhne, F. W., 723 Court St., Fort Wayne, Ind. (38). A F

Kummer, Frederic Arnold, Civil Engineer, President United States Wood Preserving Co., 29 Broadway, New York, N. Y. (51). D

Kunhardt, Wheaton B., 100 Broadway, New York, N. Y. (49).

Kunkel, Beverly Waugh, Ph. D., Instructor in Biology, Sheffield Scientific School, Yale University, New Haven, Conn. (55). F

Kuntze, Dr. Otto, Villa Girola, San Remo, Italy. (49).

*Kunz, George Frederick, Ph. D., care of Messrs. Tiffany & Co., 395 Fifth Ave., New York, N. Y. (29). 1883. C E H

*Lachman, Arthur, Ph. D., Second and Bryant Sts., San Francisco, Cal. (50). 1901. C D

*Ladd, Prof. E. F., Agricultural College, Fargo, No. Dakota. (36). 1889. C

Ladd, George Tallman, care Bass Foundry and Machine Co., Fort Wayne, Ind. (51).

Ladd, James B., Real Estate Trust Bldg., Philadelphia, Pa. (54). D

*La Fetra, Linnaeus Edford, M. D., 58 West 58th St., New York, N. Y. (50). 1906. F H K

*Laflamme, Prof. J. C. K., Laval University, Quebec, Can. (29). 1887. B E

*La Flesche, Francis, 214 First St., S.E., Washington, D. C. (33). 1885. H

*Lamb, Daniel S., M. D., 1332 Mass. Ave., N. W., Washington, D. C. (40). 1894. H

*Lambert, Preston A., 215 S. Center St., Bethlehem, Pa. (41) 1896. A

Lampard, Henry, 102 Shuter St., Montreal, Can. (40). C D E

Lanahan, Henry, Professor Physics and Civil Engineering, Maryland Agricultural College, College Park, Md. (52). B D

Lancaster, Walter B., M. D., 101 Newbury St., Boston, Mass. (51). K

*Land, William Jesse Goad, Dept. Botany, Univ. of Chicago, Chicago, Ill. (52). 1903. G

*Landacre, Francis L., Associate Professor of Zoology and Entomology, Ohio State University, Columbus, Ohio. (53). 1906. **F**

*Landes, Henry, State Geologist, Seattle, Wash. (51). 1903. **E**

Landis, Edward Horace, Instructor in Physics and Chemistry, Central High School, Philadelphia, Pa. (52). **A B C**

*Landis, Prof. W. W., Dickinson College, Carlisle, Pa. (50). 1906. **A**

Landon, Francis G., Staatsburg-on-Hudson, N. Y. (50).

*Landreth, Olin H., Professor of Engineering, Union University, Schenectady, N. Y. (28). 1883. **D**

*LANE, ALFRED C., State Geologist, Lansing, Mich. (50). 1902. **E**

Lane, Henry H., Prof. of Biology, Hiram College, Hiram, O. (55).

Lane, Horace Manley, M. D., Caixa 14 S. Paulo, Brazil, South America. (46).

Lang, Prof. Henry R., Yale University, New Haven, Conn. (41). **H**

Lange, J. D., 2626 Broadway, New York, N. Y. (49).

Lange, Philip A., Supt. Westinghouse Elec. and Mfg. Co., Pittsburg, Pa. (50). **D**

*Langenbeck, Karl, 1434 Q St., N.W., Washington, D.C. (39). 1896. **C**

Langmann, Gustav, M. D., 121 W. 57th St., New York, N. Y. (36).

*Langsdorf, Alexander Suss, Assistant Professor of Electrical Engineering, Washington University, St. Louis, Mo. (50). 1903. **B D**

Lansing, John Ernest, Hobart College, Geneva, N. Y. (52). **B C E**

Lantz, Miss Willie A., Teacher of Science, Woman's College, Frederick, Md. (54). **F G**

*Lanza, Prof. Gaetano, Mass. Institute Technology, Boston, Mass. (29). 1882. **A B D**

Laramy, Robert Edward, Teacher in Moravian School, 27 North New St., Bethlehem, Pa. (51). **E**

Lare, H. S. P., M. D., 3452 Park Ave., St. Louis, Mo. (49).

*LARKIN, EDGAR L., Director of Lowe Observatory, Echo Mountain, Cal. (51). 1903. **A**

Larkin, John Charles, M. D., Hillsboro, Ohio. (54). **K**

Larrabee, Austin P., Teacher of Biology, Salt Lake High School, Salt Lake City, Utah. (54). **F**

Latham, Vida A., M. D., 808 Morse Ave., Rogers Park, Chicago, Ill. (53). **C F K**

Lathbury, B. Brentnall, C. E., Consulting Engineer, Land Title Bldg., Philadelphia, Pa. (51). **D**

Latimer, Thos. S., M. D., 211 W. Monument St., Baltimore, Md. (50). F H K

Latta, James Edward, Teacher of Physics, Univ. of North Carolina, Chapel Hill, N. C. (54). B

Latta, John Milton, M. D., 113 N. Lawrence St., Wichita, Kans. (54). K

*Lattimore, Prof. S. A., University of Rochester, Rochester, N. Y. (15). 1874. C

Lauder, George, 7403 Penn Avenue, Pittsburg, Pa. (50).

Lauman, George Nieman, Instructor in Horticulture, Cornell University, Ithaca, N. Y. (50). G

Lavers Enoch C., Ph. D., 126 Porter St., Easton, Pa. (54). A

Law, Benedict W., Collins, N. Y. (45). E

Lawbaugh, Elmer Arthur, Oregonian Building, Portland, Oregon. (52). K

*Lawrence, A. E., 53 Devonshire St., Boston, Mass. (49). 1906. B

Lawrence, Florus F., M. D., Chief of Staff and Surgeon, Lawrence Hospital for Women, 423 East Town St., Columbus, Ohio. (53). K

*Lawrence, Harry E., Univ. of Rochester, Rochester, N. Y. (44). 1906. B

Lawrence, James W., Professor of Mechanical Engineering, Agricultural College, Fort Collins, Colo. (50). D

*Laws, Frank Arthur, Mass. Institute Technology, Boston, Mass. (47). 1906.

Laws, Samuel Spahr, LL. D., 1733 Q St., N.W., Washington, D. C. (52). H

*Lawson, Andrew C., Professor of Geology and Mineralogy, University of California, Berkeley, Cal. (50). 1901. E

Lay, Henry Champlin, Civil and Mining Engineer and Geologist, U. S. Deputy Mineral Surveyor, Telluride, Colo. (51). D E

Lazell, Ellis W., Ph. D., 1619 Filbert St., Philadelphia, Pa. (51). C

*Lazenby, W. R., Columbus, Ohio. (30). 1882. B I

*Lea, Henry C., 2000 Walnut St., Philadelphia, Pa. (54). 1906.

*Leach, Miss Mary F., 410 Church St., Ann Arbor, Mich. (44). 1896. C

*Leaming, Edward, 437 West 59th St., New York, N. Y. (50). 1901. C

*Leavitt, Frank M., Mechanical Engineer, 258 Broadway, New York, N. Y. (51). 1903. D

Leavitt, Henrietta S., Harvard College Observatory, Cambridge, Mass. (55). A

*Le Baron, J. Francis, Civil and Mining Engineer, care Señor Adolf Diaz, La Luz y Las Angeles Mines, Bluefields, Nicaragua, C. A., via Mobile, Ala. (51). 1903. **E**

*Le Brun, Mrs. Michel M., 8 Mountain Ave., S., Montclair, N. J. (35). 1892. **F**

Le Conte, Louis Julian, Civil Engineer, P. O. Box 482, Oakland, Cal. (51). **D**

Le Conte, Robert Grier, M. D., 1530 Locust St., Philadelphia, Pa. (51). **K**

*Ledoux, Albert R., Ph. D., 99 John St., New York, N. Y. (26). 1881. **C**

Lee, Edwin, Professor of Physics and Chemistry, Mt. Union College, Alliance, Ohio. (53). **B G F**

*Lee, Frederic S., Adjunct Professor of Physiology, Columbia University, New York, N. Y. (49). 1901. **K**

*Lee, Leslie A., Professor of Biology, Bowdoin College, Brunswick, Me. (52). 1906. **F**

Lee, Tennant, 318 or 319 Godchaux Bldg., New Orleans, La. (55).

Lee, Thomas G., Prof. Histology and Embryology, Medical School, Univ. of Minnesota, Minneapolis, Minn. (55).

Lee, Waldemar, 4620 Wayne St., Philadelphia, Pa. (50).

*Lee, Prof. Willis Thomas, U. S. Geological Survey, Washington, D. C. (47). 1902. **E F**

*Leeds, Morris E., 3221 North 17th St., Philadelphia, Pa. (50). 1906.

*Lefavour, Henry, President Simmons College, Boston, Mass. (42). 1894. **B**

Lefevre, George, Ph. D., Univ. of Missouri, Columbia, Mo. (55). **F**

*LeGras, Gustave, Asst. Prof. Mathematics, College of the City of N. Y., New York, N. Y. (54). 1906. **A**

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Leisen, Theo. Alfred, Civil Engineer, Wilmington, Del. (51). **B C D G**

*Leith, Charles Kenneth, Professor of Economic and Structural Geology, University of Wisconsin, Madison, Wis. (53). 1906. **E**

Leland, Ora Miner, College of Civil Engineering, Cornell Univ., Ithaca, N. Y. (54). **A D**

Lemley, C., McC., Asst. Engineer, B. & O. R. R. Co., 1712 N Calvert St., Baltimore, Md. (51). **D**

Lemon, James S., Ph. D., 31 Park St., Gardner, Mass. (51). **I K**

Leng, Charles W., 119 Columbia St., West New Brighton, Staten Island, N. Y. (54). **F**

*Lengfeld, Felix, Ph. D., Consulting and Manufacturing Chemist, 202 Stockton St., San Francisco, Cal. (51). 1903. **C**

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*Lennon, William H., State Normal School, Brockport, N. Y. (31) 1894. **C G**

Leonard, John William, Editor of "Who's Who in America," Wheaton, Ill. (50). **I**

Lesley, Robert W., 604 Pennsylvania Building, Philadelphia, Pa. (54).

Letson, Miss Elizabeth J., Buffalo Society of Natural Sciences, Buffalo, N. Y. (47).

*Levene, Dr. P. A., 154 W. 132d St., New York, N. Y. (53). 1906. **K**

*Leverett, Frank, 312 N. Thayer St., Ann Arbor, Mich. (37). 1891. **E**

Leverson, Montague Richard, M. D., 1322 Kerlerec St., New Orleans, La. (54). **K**

*Levy, Ernest C., M. D., 615 East Franklin St., Richmond, Va. (54). 1906. **C K**

Lewis, A. B., Seward, Alaska. (55). **D**

Lewis, Miss Bertha, Acorn Club, 1618 Walnut St., Philadelphia, Pa. (54).

LEWIS, CLARENCE MCKENZIE, care Wm. Salomon & Co., 25 Broad St., New York, N. Y. (47). **D**

*Lewis, E. Percival, Associate Professor of Physics, University of California, Berkeley, Cal. (53). 1905. **B**

Lewis, George Smith, 746 State St., Springfield, Mass. (44). **G**

*Lewis, J. Volney, Rutgers College, New Brunswick, N. J. (45). 1900. **C E**

*Lewis, Wilfred, Pres. The Tabor Mfg. Co., 5901 Drexel Road, Philadelphia, Pa. (51). 1906. **D**

Lewton, Frederick Lewis, U. S. Dept. Agriculture, Washington, D. C. (54). **F G**

Lewton-Brain, L., Asst. Director, Div. Path. or Physiol. Exper. Sta., H. S. P. A., Honolulu, T. H. (55). **K**

*Libbey, Prof. William, Princeton, N. J. (29). 1887. **E F**

Lichthardt, G., Jr., 1800 M St., Sacramento, Cal. (50). **C**

Lichty, Daniel, M. D., Masonic Temple, Rockford, Ill. (52). **K**

Lieber, Hugo, 25 West Broadway, New York, N. Y. (53). **C**

Light, Dr. Gertrude Underhill, Women's University Club, 17 Madison Sq. N., New York, N. Y. (53). **K**

Lightfoot, Thos. Montgomery, Asst. Prof. of Physical Science, Central High School, Philadelphia, Pa. (51). **G**

Lightner, Calvin R., M. D., 2313 Washington Ave., St. Louis, Mo (53). K

*Lillie, Frank R., Professor of Zoology, University of Chicago, Chicago, Ill. (50). 1901. F

*Lincoln, Paul Martyn, Electrical Engineer, Pittsburg, Pa. (50). 1903. D

Lindahl, John Harold Josua, Ph. D., P. O. Box 597, Cincinnati, Ohio. (55). F

Lindenkohl, Henry, U. S. C. and G. Survey, Washington, D. C. (47).

*Lindenthal, Gustav, C. E., 45 Cedar St., New York, N. Y. (37). 1891. I

*Lindgren, Waldemar, U. S. Geological Survey, Washington, D. C. (53). 1906. E

*Lindley, Ernest H., Professor Psychology, University of Indiana, Bloomington, Ind. (52). 1905. K

Lindsay Alexander M., Rochester, N. Y. (41).

*Lindsay, Samuel McCune, Prof. of Sociology, Univ. of Pa., Philadelphia, Pa. (54). 1906. I

*Lindsey, Edward, Warren, Pa. (48). 1906. H I

Lines, Edwin Fuller, U .S. Geological Survey, Washington, D. C. (54). E

Linford, James Henry, President of the Brigham Young College, Logan, Utah. (52). F

*Ling, Charles Joseph, Instructor in Physics, Manual Training High School, Denver, Colo. (50). 1901. A B

*Ling George Herbert, Ph. D., Tutor in Mathematics, Columbia University, New York, N. Y. (52). 1906. A

Link, Theodore Carl, Carleton Bldg, St. Louis, Mo. (51). I

*Linn Alvin Frank, Ph. D., Professor of Chemistry, Wittenberg College, Springfield, Ohio. (50). 1901. C

Linn, George A., M. D., P. O. Box 813, Monongahela, Pa. (51). K

*Linton, Edwin, Biological Laboratory, Washington and Jefferson College, Washington, Pa. (51). 1905. F

*Linville, Henry R., 104 West 70th St., New York, N. Y. (40). 1906.

Lion, Léon Elie, C. E., Assistant on U. S. Engineer Corps, 1010 Burgundy St., New Orleans, La. (51). D

Lipp, Charles Clinton, Asst. Veterinarian Minn. Exper. Station, St. Paul, Minn. (53). K

Lischer, Benno Edward, M. D., 504 Humboldt Bldg., St. Louis, Mo. (53). K

Litchfield, Lawrence, M. D., 5431 Fifth Ave., Pittsburg, Pa. (51). K

*Littell, Frank B., U. S. Naval Observatory, Washington, D. C. (49). 1903. A

*Little, Arthur D., Chemist, 93 Broad St., Boston, Mass. (54). 1906. C

Little, Henry P., Superintendent of Union Schools, Momence, Ill. (50). B

*Littlehales, G. W., U. S. Hydrographic Office, Washington, D. C. (52). 1903. A B D E

Livermore, Mrs. M. A. C., Prescott St., Longwood, Mass. (29). F

*Livingston, Burton Edward, Ph. D., U. S. Dept. Agriculture, Washington, D. C. (53). 1906. G

Livingston, Max, 1158 So. Broad St., Philadelphia, Pa. (54). D

Lloyd, Andrew J., 315 Washington St., Boston, Mass. (47). B H

*Lloyd, Francis E., Department of Botanical Research of the Carnegie Institution of Washington, Tucson, Arizona. (48). 1901. G

*Lloyd, John Uri, Court and Plum Sts., Cincinnati, Ohio. (38). 1890. C F

*Lloyd, Morton Githens, Ph. D., Bureau of Standards, Washington, D. C. (52). 1906. B

Lloyd, T. Mortimer, M. D., 125 Pierrepont St., Brooklyn, N. Y. (51). K

Lobenstine, William C., 245 Central Park, W., New York, N. Y. (49).

*Lochhead, William, Professor of Biology, Macdonald College, Montreal, Can. (51). 1906. F

Lockwood, Cornelius Wygant, Teacher of Science, Newburg Academy, Newburgh, N. Y. (50). B E

Lockwood, Edwin Hoyt, Asst. Prof. Mechanical Engineering, Yale University, New Haven, Conn. (50). D

Lodholz, Edward, M. D., University of Pennsylvania, Philadelphia, Pa. (53). K

*Loeb, Leo, M. D., University of Pennsylvania, Philadelphia, Pa. (51). 1905. K

*Loeb, Morris, Ph. D., 273 Madison Ave., New York, N. Y. (36). 1889. C

*Loew, Dr. Oscar, Komaba, Tokyo, Japan. (49). 1900. G

*Loewenstein, Louis C., Instructor in Mechanical Engineering, Lehigh Univ., So. Bethlehem, Pa. (54). 1905. D

Loewy, Benno, 206 and 208 Broadway, New York, N. Y. (41).

Logan, Frank G., 2919 Prairie Ave., Chicago, Ill. (42). H

LOGAN, WALTER S., 27 William St., New York, N. Y. (36).

Lomb, Adolph, P. O. Drawer 1033, Rochester, N. Y. (41).

Lomb, Henry, P. O. Drawer 1033, Rochester, N. Y. (41).

Lomb, Henry C., P. O. Drawer 1033, Rochester, N. Y. (43).

*Long, Prof. John H., 2421 Dearborn St., Chicago, Ill. (41). 1895. C

Long, William Henry, Jr., Denton, Texas. (50).

Longaker, Daniel, M. D., 1402 N. 16th St., Philadelphia, Pa. (53). K

*Longden, A. C., Ph. D., Professor of Physics, Knox College, Galesburg, Ill. (49). 1901. B

*Longstreth, Morris, 1416 Spruce St., Philadelphia, Pa. (54). 1906.

*Loomis, Elmer Howard, Prof. Physics, Princeton Univ., Princeton, N. J. (54). 1906. B

Loomis, Frederick B., Ph. D., Assistant in Zoology, Amherst College, Amherst, Mass. (50). F

Lord, John Prentiss, M. D., 3421 Forman St., Omaha, Neb. (55). K

*Loubat, le Duc de, 47 rue Dumont d'Urville, Paris, France. (46). 1897. H

*Louderback, George Davis, Nevada State University, Reno, Nevada. (50). 1906. E

*Lough, Dr. J. E., New York University, Washington Square, New York, N. Y. (50). 1901. I

*Loughridge, Dr. R. H., Univ. of California, Berkeley, Cal. (21). 1874. C E

Lounsbury, Charles P., Government Entomologist, Dept. of Agriculture, Cape Town, South Africa. (52). F

*Love, Edward G., 80 E. 55th St., New York, N. Y. (24). 1882. C

*Love, James Lee, Asst. Prof. Mathematics, Harvard Univ., Cambridge, Mass. (54). 1906. A

Lovejoy, J. R., Genl. Elec. Co., Schenectady, N. Y. (50). D

Loveland, Horace Hall, M. D., Newark, N. J. (51). K

*Lovett, Edgar Odell, Professor of Mathematics, Princeton University, Princeton, N. J. (51). 1902. A

Low, A. A., Columbia Heights, Brooklyn, N. Y. (43). A

Low, Clarence F., Liverpool, London, Globe Bldg., New Orleans, La. (52). I

*Low, Hon. Seth, 30 East 64th St., New York, N. Y. (29). 1890.

*Lowber, Rev. James William, Ph. D., 113 East 18th St., Austin, Texas. (50). 1906. H I

Lowe, E. N., M. D., Assistant in Biology, The University of Mississippi, University, P. O., Miss. (55). K

Lowe, Houston, V. P., The Lowe Bros. Co., Dayton, Ohio. (52). G

Lowe, Morgan M., M. D., 621 Opelousas Ave., Algiers, La. (55). K

Lowell, Percival, 53 State St., Boston, Mass. (36). 1896. A

Lowell, Russell C., 420 Hope St., Providence, R. I. (51).

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Luckey, John Eddy, M. D., Vinton, Ia. (51). I K

Ludlow, Miss Clara S., The Plaza, Washington Circle, Washington, D. C. (54).

*Ludlow, Henry Hunt, Major U. S. A., Agricultural College, Miss. (54). 1906. A

*Ludlow, Jacob Lott, C. E., 434 Summit St., Winston, N. C. (50). B D

Luebkert, Otto, American Audit Co., Colorado Building, Washington, D. C. (50). I

Lufkin, Albert, Newton, Iowa. (31). D E

Lukens, Herman T., South-Western State Normal School, California, Penna. (55). H I

Lull, Richard S., Amherst, Mass. (43). F H

Lund, James, 142 Hawthorne St., Malden, Mass. (45).

Lund, Robert Leathan, 4160 McPherson Ave., St. Louis, Mo. (53). D

*Lundin, Carl A. R., care Messrs. Alvan Clark and Sons, Cambridgeport, Mass. (47). 1906. A

*Luquer, Lea McIlvane, Columbia University, New York, N. Y. (49). 1902. E

*Lusk, Graham, 11 E. 74th St., New York, N. Y. (54). 1906. F K

Luther, Miss Agnes Vinton, 151 Scotland Road, South Orange, N. J. (47). E

Lutz, Anne M., Secretary Station for Exper. Evolution, Cold Spring Harbor, L. I., N. Y. (54). F

Lutz, Frank Eugene, Station for Experimental Evolution, Cold Spring Harbor, L. I., N. Y. (53). F

Lybrand, Mrs. William M., The Clinton, Philadelphia, Pa. (54). I

*Lyford, Edwin F., Springfield, Mass. (33). 1896. B C H

*Lyle, David A., Lieut. Colonel U. S. Army, Augusta Arsenal, Augusta, Ga. (28). 1880. D

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Lyman, Chester W., Assistant to President of International Paper Co., 30 Broad St., New York, N. Y. (50). I

Lyman, Elmer A., Professor of Mathematics, Michigan State Normal School, Ypsilanti, Mich. (53). A

Lyman, Henry H., F. R. G. S., F. E. S., 74 McTavish St., Montreal, Can. (29). E F

Lyman, James, Engineer, Western District, Genl. Elec. Co., 1047 Monadnock Bldg., Chicago, Ill. (50). D

LYMAN, THEODORE, Instructor in Physics, Harvard Univ., Cambridge, Mass. (55). B

Lynch, William H., Springfield, Mo. (52). I

Lyon, Marcus Ward, Jr., U. S. National Museum, Washington, D. C. (53).

Lyon, Scott Cary, Asst. Pr. of Science, Southwestern Presbyterian University, Clarksville, Tenn. (55). **B C**

Lyons, Albert Brown, M. D., Consulting Chemist, 72 Brainard St., Detroit, Mich. (50). **C K**

*Lyons, Robert E., Professor of Chemistry, University of Indiana, Bloomington, Ind. (51). 1906. **C**

*Mabery, Prof. C. F., Case School of Applied Science, Cleveland, Ohio. (29). 1881. **C**

McAdam, D. J., Teacher of Mathematics, Washington and Jefferson College, Washington, Pa. (51). **A**

*MacAlister, James, President Drexel Institute, Philadelphia, Pa. (54). 1906. **I**

*McAllister, Cloyd North, Ph. D., Instructor in Psychology, Yale University, New Haven, Conn. (52). 1906. **K**

McAlvin, J. G., M. D., 301 Main St., Cedar Falls, Iowa. (52). **K**

McArthur, Lewis L., M. D., 1415 Drexel Blvd., Chicago, Ill. (51). **K**

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Macbeth, George A., 717 Amberson Ave., Pittsburg, Pa. (50). **D H**

McBeth, William A., Asst. Professor of Geography, State Normal College, Terre Haute, Ind. (53). **E**

McBride, Hon. George Wickliffe, Portland, Oregon. (51). **I**

McBride, Jas. H., M. D., Pasadena, Cal. (51). **K**

*Macbride, Thomas H., Iowa City, Iowa. (38). 1890. **G**

McCartney, Dr. James H., 929 Lake Ave., Rochester, N. Y. (41). **A B**

McCaskey, H. D., Chief, Division of Mines, Bureau of Science, Manila, P. I. (55). **E**

*McCauley, C. H. A., Colonel and Assistant Quartermaster-General, U. S. A., 532 Equitable Bldg., Denver, Colo. (29). 1881.

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McClelland, James H., M. D., 5th and Wilkins Aves., Pittsburg, Pa. (50). **F K**

*McClintock, Emory, 32 Nassau St., New York, N. Y. (43). 1895. **A**

McClung, Clarence E., Ph. D., Professor of Zoology, University of Kansas, Lawrence, Kan. (52). **F**

McClure, Geo. E., Missouri Botanical Garden, St. Louis, Mo. (53). **G**

McCormick, Florence Anna, Dept. Natural Science, Winthrop Normal and Industrial College, Rockhill, S. C. (55).

McCormick, Rev. Samuel Black, D. D., LL. D., Chancellor Western Univ. of Pennsylvania, Allegheny City, Pa. (54).

MacCracken, John Henry, Ph. D., LL. D., Syndic of New York University, New York, N. Y. (52). **I**

McCracken, M. Isabel, Stanford Univ., Calif. (54). **F**

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McCullough, Laurence Hugh, 5th Dist. Agric. School, Wetumpka, Alabama. (54). C G

McCune, M. Virginia, M. D., 506 West John St., Martinsburg, W. Va. (51). K

McCurdy, Arthur W., 497 Esquimalt Road, Victoria, West, B. C. (52).

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McCurdy, Hansford M., 26E Shepard St., Cambridge, Mass. (51). F G

McDermott, Rev. P. A., Roman Catholic Mission, Old Calabou, Nigeria, West Africa. (51). E H I

Macdonald, Benjamin J., 296 Grand St., Newburgh, N. Y. (50). I

McDonnell, Curtis C., Asst. Chemist Agric. Exper. Station, Clemson College, S. C. (51). C

*McDonnell, Prof. Henry B., College Park, Md. (40). 1893. C

*MacDougal, Daniel T., N. Y. otanical Garden, Bronx Park, New York, N. Y. (44). 1897. G

MacDougall, George R., 131 West 73d St., New York, N. Y. (49).

*MacDougall, Robert, Ph. D., Sedgwick Park, Bronx, New York, N. Y. (49). 1901. H K

McDowell, Edward Campbell, care The American Car and Foundry Co., 107 Walnut St., Berwick, Pa. (54). D

*McElfresh, William Edward, Williamstown, Mass. (53). 1906 B

McFadden, Prof. L. H., Otterbein University, Westerville, Ohio. (32). B C

McFadden, Thomas Gilbert, Lebanon Valley Coll., Annville, Pa. (48). C

MacFarland, W. W., 22 William St., New York, N. Y. (49).

*Macfarlane, Prof. A., Victoria Av, Chatham, Ontario, Can. (34). 1886. A B

*Macfarlane, Hon. James R., Judge of Court of Common Pleas No. 1, Court House, Pittsburg, Pa. (50). 1906. E

*Macfarlane, John M., 4320 Osage Ave., Philadelphia, Pa. (41). 1999. F G

McGahan, Chas. F., M. D., Aiken, S. C. (51). K

*McGee, Dr. Anita Newcomb, Public Museum, S. W. Cor. 3d and Pine Sts., St. Louis Mo. (37). 1892. H

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*McGill, John T., Ph. D., Vanderbilt University, Nashville, Tenn. (36). 1888. **C**

*McGilvary, Evander Bradley, University of Wisconsin, Madison, Wis. (54). 1906. **I**

*McGregor, James Howard, Columbia University, New York, N. Y. (52). 1905. **F**

*McGregory, Prof. J. F., Colgate University, Hamilton, N. Y. (35). 1892. **C**

*McGuire, Joseph D., 1834 16th St., N. W., Washington, D. C. (51). 1902. **H**

Machalske, Florentin J., Ph. D., Analytical and Consulting Chemist, P. O. Box 25, Station W, Brooklyn, N. Y. (52). **C**

McHatton, Henry, M. D., Macon, Ga. (52). **K**

MacIntyre, Miss Lucy, 303 West 74th St., New York, N. Y. (49).

Mack, Bernard J., 209–10 Cutting Bldg., Joliet, Ill. (54). **C**

Mack, Jacob W., 92 Liberty St., New York, N. Y. (49).

McKay, John S., Ph. D., Packer Collegiate Institute, Brooklyn, N. Y. (52).

McKee, Ralph Harper, Ph. D., Professor of Chemistry, Lake Forest University, Lake Forest, Ill. (53). **C**

McKelvy, William H., M. D., President Board of Education, 420 6th Ave., Pittsburg, Pa. (50). **I**

McKelway, A. J., Charlotte, N. C. (55). **I**

*McKenney, Randolph Evans Bender, Ph. D., care United Fruit Co., Bocas del Toro, Panama. (51). 1903. **G**

McKeown, W. W., Jr., Mining Engineer, Room 607, No. 160 Washington St., Chicago, Ill. (51). **D E**

*McKinney, Thomas Emery, Professor of Mathematics and Astronomy, Marietta College, Marietta, Ohio. (50). 1906. **A**

Mackintosh, Roger S., Professor of Horticulture, Agric. Exper. Station, Auburn, Ala. (53). **G**

McLain, Louis Randolph, Pres. of Florida Engineering Co., St. Augustine, Fla. (51). **D**

McLanahan, George William, 1601 21st St., N.W., Washington, D. C. (50).

McLaughlin, A. C., Houston Oil Co. of Texas, Houston, Texas, (52). **C D E**

McLaughlin, George Eyerman, M. D., 41 Crescent Ave., Jersey City, N. J. (47). **F H**

McLaughlin, Thomas N., 1226 N St., N.W., Washington, D. C. (52).
McLaury, Howard L., Prof. of Mathematics and Physics, So. Dakota School of Mines, Rapid City, So. Dak. (50). **A B**
Maclay, James, Ph. D., Adjunct Professor of Mathematics, Columbia University, New York, N. Y. (52). **A**
McLean, Miss Charlotte F., Linden Hall, Lititz, Pa. (54).
*MacLean, George Edwin, President of the State University of Iowa, Iowa City, Iowa. (52). 1903. **I**
*McLennan, John C., Professor of Physics, Toronto University, Toronto, Ontario, Can. (51). 1903. **B**
Macleod, John James Rickard, Western Reserve Medical College, Cleveland, Ohio. (55). **K**
*Macloskie, Prof. George, Princeton Univ., Princeton, N. J. (25). 1882. **F G**
*McMahon, Prof. James, Cornell University, Ithaca, N. Y. (36). 1891. **A B**
*MacMillan, Conway, University of Minnesota, Minneapolis, Minn. (53). 1906. **G**
McMillan, Smith B., Signal, Ohio. (37).
McMillin, Emerson, 40 Wall St., New York, N. Y. (37).
McMullen, Joseph Francis, 1908 Nora Ave., Spokane, Washington. (52). **E G**
McMurray, Fred. R., 527 West 151st St., New York, N. Y. (53).
*McMurtrie, William, 480 Park Ave., New York, N. Y. (22). 1874. **C**
*McNair, Fred Walter, President Michigan College of Mines, Houghton, Michigan. (51). 1902. **B D**
McNeil, Hiram Colver, 1292 Mt. Vernon Ave., Columbus, Ohio. (51) **B C**
*McNeill, Malcolm, Professor Mathematics and Astronomy, Lake Forest University, Lake Forest, Ill. (32). 1885. **A**
McNulty, Geo. Washington, Civil Engineer, 258 Broadway, New York, N. Y. (51). **D**
*McNulty, John J., Ph. D., College of City of New York, New York, N. Y. (50). 1906.
*MacNutt, Barry, Lehigh University, So. Bethlehem, Pa. (47). 1900. **B**
*McPherson, Prof. Wm., Ohio State Univ., Columbus, Ohio. (45). 1898. **C**
McQueeney, Francis J., M. D., 46 Dartmouth St., Boston, Mass. (51). **K**
*McRae, Austin Lee, Professor of Physics, School of Mines and Metallurgy, University of Missouri, Rolla, Mo. (39). 1891. **B**
*MacVannel, John Angus, Instructor in Philosophy and Education, Columbia University, New York, N. Y. (52). 1905. **I**
Macy, V. Everit, 68 Broad St., New York, N. Y. (49).

Madison, Harold L., Professor of Natural Science, Southwestern Baptist Univ., Jackson, Tenn. (55). **F**

Magee, Louis J., Electrical Engineer, 25 Broad St., New York, N. Y. (50). **B D**

*Magie, Prof. Wm. Francis, Princeton University, Princeton, N. J. (35). 1887. **B**

Magnusson, Carl Edward, Ph. D., University of Washington, Seattle, Wash. (51). **D**

Magruder, Egbert W., Chemist, Department of Agriculture, Richmond, Va. (51). 1906. **C**

*Magruder, Wm. T., Ohio State Univ., Columbus, Ohio. (37). 1899.

Maher, John J., 1535 Franklin St., Philadelphia, Pa. (53). **F**

Mahoney, Stephen A., M. D., 206 Maple St., Holyoke, Mass. (51). **K**

Maignen, Prosper Auguste, 52 N. 13th St., Philadelphia, Pa. (54).

*Major, David R., Ph. D., Prof. of Education, Ohio State University, Columbus, Ohio. (51). 1906. **H I**

*Mallet, J. W., University of Virginia, Charlottesville, Va. (52). 1906.

Mallinckrodt, Edw., P. O. Sub-Station A, St. Louis, Mo. (29). **C**

MALLINCKRODT, EDW., JR., 26 Vandeventer Place, St. Louis, Mo. (53). **C**

*Mallory, Frank Burr, M. D., Harvard Medical School, Boston, Mass. (54). 1906. **K**

Mally, Charles William, Graham's Town, Cape Colony, So. Africa. (46).

Mally, Fred'k William, Garrison, Tex. (50). **F G**

*Maltby, Margaret E., Ph. D. Barnard College, New York, N. Y. (46). 1898. **B**

Mangan, Daniel C., M. D., 95 Park Ave., Brooklyn, N. Y. (50). **F K**

Mann, Albert, Ph. D., 1216 Connecticut Ave., N.W., Washington, D. C. (43). **G**

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Manning, Charles H., U. S. N., Manchester, N. H. (35). **D**

Manning, Miss Eva, 1330 Columbia Road, Washington, D. C. (52). **E H**

Manning, Henry Parker, Brown Univ., Providence, R. I. (55).

Manning, J. Woodward, 1101 Tremont Building, Boston, Mass. (47). **G**

Manning, Warren H., Brookline, Mass. (31). **E F H**

Mansfield, Albert K., 125 Lincoln Ave., Salem, Ohio. (51). **D**

Manson, Marsden, Comm'r of Public Works, 2010 Gough St., San Francisco, Cal. (51). **D**

Manwaring, Dr. Wilfred Hamilton, Assoc. Prof. Pathology and Bacteriology, Indiana Univ., Bloomington, Ind. (55). **K**

Mapes, Charles Victor, 60 W. 40th St., New York, N. Y. (37). **C**

Marble, J. Russel, Worcester, Mass. (31). **C E**

MARBLE, MANTON, Bedford, N. Y. (36).

*Mark, E. H., Superintendent of Public Schools, Center and Walnut Sts., Louisville, Ky. (39). 1893. **B**

*Mark, Edward Laurens, Director Zoological Laboratory, Harvard University, Cambridge, Mass. (50). 1901. **F**

Markham, George Dickson, 4961 Berlin Ave., St. Louis, Mo. (50).

Marks, Louis B., 687 Broadway, New York, N. Y. (50).

*Marks, William Dennis, C. E., The Art Club, Philadelphia, Pa. (50). 1906. **I**

Marlatt, Miss Abby L., Manual Training High School, Providence, R. I. (48).

*Marlatt, Charles L., U. S. Department Agriculture, Washington, D. C. (40). 1895. **F**

Marlow, Frank William, M. D., 200 Highland St., Syracuse, N. Y. (50). **F H I K**

MARMOR, REV. J. D., 348 E. 20th St., New York, N. Y. (52). **E H K**

Marple, Charles A., 382 Sibley St., Cleveland, Ohio. (39). **B**

Marquis, J. Clyde, carePhelps Pub. Co.,Springfield, Mass. (53). **G**

*Marsh, C. Dwight, 3525 10th St., N.W., Washington, D. C. (34). 1893. **E F**

Marsh, James P., M. D., 1828 5th Ave., Troy, N. Y. (51). **K**

Marsh, Millard C., Bureau of Fisheries, Washington, D. C. (54).

Marshall, Horace Miller, U. S. Engineer Office, Vicksburg, Miss. (51). **D**

Marston, Edwin S., South Orange, N. J. (50).

*Martin, Artemas, Ph. D., LL.D., U. S. Coast and Geodetic Survey. Washington, D. C. (38). 1890. **A**

*Martin, Daniel S., 756 Quincy St., Brooklyn, N. Y. (23). 1879. **E F**

*Martin, Emilie Norton, Ph. D., Montreat, N. C. (54). 1906. **A**

*Martin, F. W., Ph. D., Dir. Chem. Lab., Randolph-Macon Woman's College, College Park, Va. (49). 1905. **C**

*Martin, George C., U. S. Geological Survey, Washington, D. C. (51). 1903. **E**

Martin, Geo. W., Professor of Biology, Vanderbilt University, Nashville, Tenn. (52). **F**

*Martin, Louis Adolphe, Jr., Instructor in Mathematics and Mechanics, Stevens' Institute, Hoboken, N. J. (53). 1906. **A B D**

Martin, L. J. Asst. Prof. Psychology, Stanford University, Calif. (54). 1906. **F**

Martin, William Lyon, Augusta, Ga. (50). **H**

*Marvin, C. F., U. S. Weather Bureau, Washington, D. C. (39). 1892. **B**

*Marvin, Frank O., Dean School of Engineering, University of Kansas, Lawrence, Kan. (35). 1894. **D**

Marvin, Harry Norton, Canastota, N. Y. (50). **D**

Marvin, Joseph B., M. D., LL. D., President Kentucky University, Louisville, Ky. (51). **I**

Mason, Herbert Warren, 161 Devonshire St., Boston, Mass. (53). **D**

Mason, Miss Nellie M., Teacher of Science, Abbot Academy, Andover, Mass. (50). **B C**

*Mason, Otis T., Ph. D., LL. D., U. S. National Museum, Washington, D. C. (25). 1877. **H**

*Mason, Dr. William P., Rensselaer Polytechnic Inst., Troy, N. Y. (31). 1886. **C**

Massey, Wilbur Fisk, Botanist and Horticulturist, Agricultural Exper. Station, Raleigh, N. C. (51). **G**

Mast, Samuel Ottnear, 65 E. 10th St., Holland, Mich. (52).

*Matas, Rudolph, M. D., Professor of Surgery, Tulane University, New Orleans, La. (50). 1906. **H K**

Mateer, Horace N., M. D., Wooster, Ohio. (36). **E F**

Matheson, Wm. J., 182 Front St., New York, N. Y. (54). **I**

*Mathews, John A., Ph. D., Crucible Steel Co, of America, Experimental Dept., Syracuse, N. Y. (50). 1902. **C E**

Mathews, Miss Mary Elizabeth, Lake Erie College, Painesville, Ohio. (41).

Matlack, Charles, "Hidden Hearth," R. F. D. No. 1, Wakefield, R. I. (27). **I**

Matthes, Francois E., U. S. Geological Survey, Washington, D. C. (52). **E**

*Matthew, William Diller, Ph. D., American Museum of Nat. Hist., New York, N. Y. (54). 1906. **E F**

Matthews, Albert, 483 Beacon St., Boston, Mass. (51). **H**

Mattison, Fitch C. E., M. D., 295 W. California St., Pasadena, Cal. (51). **K**

Mattoon, A. M., Scott Observatory of Park College, Parkville, Mo. (47). **A**

*Maurer, Edward R., Professor of Mechanics, University of Wisconsin, Madison, Wis. (53). 1906. **D**

Max, C. O. C., M. D., 3862 Olive St., St. Louis, Mo. (53). **K**

*Maxon, William R., U. S. National Museum, Washington, D. C., (49). 1906. **G**

Maxwell, Fred. Baldwin, Ph. D., 308 Franklin Ave., River Forest, Oak Park P. O., Ill. (51). **F**

Maxwell, George H., Executive Chairman, National Irrigation Association, 812 Whitehall Bldg., New York, N. Y. (50). E

Maxwell, Hu., Treasurer Transallegheny Historical Society, Morgantown, W. Va. (50). E

*Mayer, Alfred Goldsborough, S. D., M. E., Director Marine Biological Laboratory. Carnegie Institution, Tortugas, Fla. (47). 1900. F

Maynard, Washburn, Rear Admiral U. S. N., Retired, Narragansett Pier, R. I. (33). B

Mayo, Caswell A., 1536 Fiftieth St.. Brooklyn, N. Y. (52).

*Mead, Albert Davis, Brown University, Providence, R. I. (52). 1905. F

Mead, Chas. S., 217 King Ave., Columbus, Ohio. (52). F

*Mead, Elwood, U. S. Department Agriculture, Washington, D. C. (51). 1902. D

Means, James, 196 Beacon St., Boston, Mass. (47).

*Mearns, Maj. Edgar A., M. D., Surgeon U. S. A., Manila, P. I. (49). 1901. K

Mebus, Charles F., 908–909 Land Title Bldg., Philadelphia, Pa. (54).

Medsger, Oliver P., 106 Argyle Place, Arlington, N. J. (50). G

Meehan, S. Mendelson, Germantown, Philadelphia, Pa. (51). G

Meek, Walter J., Professor of Biology, Penn College, Oskaloosa, Iowa. (53). F

*Mees, Prof. Carl Leo, Rose Polytechnic Institute, Terre Haute, Ind. (24). 1876. B C

Meigs, Edward B., M. D., University of Pennsylvania, Philadelphia, Pa. (53). K

Meigs, Montgomery, U. S. A., U. S. Civil Engineer, U. S. Eng'r Office, Keokuk, Iowa. (51). D

Melchers, William Julius, Gen. Mgr. Union Telephone Co. Alma, Mich. (55). D

*Mell, P. H., Ph. D., President Clemson Agricultural College, Clemson College, S. C. (39). 1895. E G

Mellor, Alfred, President of the Mellor and Rittenhouse Co., 2130 Mt. Vernon St., Philadelphia, Pa. (51).

Mellor, Charles C., 319 Fifth Ave., Pittsburg, Pa. (38).

*Meltzer, S. J., M. D., 107 West 122d St., New York, N. Y. (49). 1901. K

Mendel, Lafayette B., Ph. D., Sheffield Scientific School, Yale University, New Haven, Conn.

*Mendenhall, Charles E., Ph. D., University of Wisconsin, Madison, Wis. (48). 1900. B

*Mendenhall, Prof. T. C., Worcester, Mass. (20). 1874. B

*Mendenhall, Walter Curran, U. S. Geological Survey, Washington, D. C. (52). 1903. E

Mengel, Prof. Levi W., Boys High School, Reading, Pa. (52).

*Mercer, H. C., Doylestown, Pa. (41). 1893. H

Mercer, William Fairfield, Ph. D., Professor of Biology, Ohio University, Athens, Ohio. (50). F

Merrell, Miss Caroline Wallace, 2950 Frankford Ave., Philadelphia, Pa. (54). G

*Merriam, Dr. C. Hart, U. S. Department Agriculture, Washington, D. C. (49). 1900. F

*Merriam, John C., Ph. D., Assistant Professor of Paleontology and Historical Geology, Univ. of California, Berkeley, Calif. (52). 1905. E

Merrick, J. Vaughan, Roxborough, Philadelphia, Pa. (54).

Merrill, Elmer Drew, Botanist Bureau of Science, Dept. of the Interior, Manila, P. I. (50). G

*MERRILL, FREDERICK J. H., Ph. D., New York State Museum, Albany, N. Y. (35). 1887. E

Merrill, Joseph Francis, Ph. D., Professor of Physics and Electrical Engineering, University of Utah, Salt Lake City, Utah. (50). B D

Merrill, Lucius Herbert, Professor of Biological Chemistry, University of Maine, Orono, Maine. (50). C

MERRILL, MRS. WINIFRED EDGERTON, Ph. D., 268 State St., Albany, N. Y. (35). A

*Merriman, C. C., 1910 Surf St., Lake View, Chicago, Ill. (29). 1880. F

*Merriman, Mansfield, Professor of Civil Engineering, Lehigh University, So. Bethlehem, Pa. (32). 1885. A D I

*Merritt, Ernest, Cornell University, Ithaca, N. Y. (33). 1890. B

*Merrow, Miss Harriet L., Rhode Island College of Agriculture and Mechanic Arts, Kingston, R. I. (44). 1906. G

Merry, J. L., Immigration Agent, Illinois Central Ry., Manchester, Iowa. (55).

Merryweather, George N., 639 Forest Ave., Avondale, Cincinnati, Ohio. (30). F H

*Mershon, Ralph D., Consulting Engineer, 621 Broadway, New York, N. Y. (50). 1906. D

*Messenger, Hiram John, 637 Farmington Ave., Hartford, Conn. (54). 1906. I

*Messenger, J. Franklin, Ph. D., Farmville, Va. (52). 1905. H K

*Metcalf, Haven, U. S. Dept. Agriculture, Washington, D. C. (52). 1903. G

*Metcalf, Maynard M., Ph. D., Professor of Biology, The Woman's College, Baltimore, Md. (50). 1901. F

METCALF, ORLANDO, 424 Telephone Building, Pittsburg, Pa. (35). D

*Metcalf, William, 1 Fulton St., Pittsburg, Pa. (33). 1894. D

Metcalf, Wilmot V., care James Gane, West Williamsfield, O. (50). B C

Metcalfe, Captain Henry, 143 Liberty St., New York, N. Y. (50).

Metz, Dr. A. L., Prof. Chemistry, Medical Dept., Tulane Univ., New Orleans, La. (55). K

*Metzler, William H., Ph. D., Syracuse University, Syracuse, N. Y. (45). 1899. A

*Meyer, Adolf, M. D., Director of Pathological Institute of N. Y. State Hospital, Ward's Island, New York, N. Y. (52). 1905. K

Meyer, J. Frank, Univ. of Penna., Philadelphia, Pa. (51). B

*Meyer, Max, Ph. D. Professor of Psychology, University of Missouri, Columbia, Mo. (49). 1901. H I

Meylan, George L., M. D., Columbia University, New York, N. Y. (53). K

*Mezes, Sidney Edward, Professor of Philosophy, University of Texas, Austin, Texas. (50). 1901. I

Miles, George F., U. S. Dept. Agriculture, Washington, D. C. (54). G

*Milham, Willis I., Williams College, Williamstown, Mass. (47). 1905. A B

Millar, John M., Escanaba, Mich. (50).

Miller, Armand R., Professor of Chemistry, McKinley High School, St. Louis, Mo. (50). C

*Miller, Arthur M., Professor of Geology and Zoology, State College, Lexington, Ky. (45). 1898. E

Miller, Benjamin LeRoy, Dept. Geology, Bryn Mawr College, Bryn Mawr, Pa. (50). E

*Miller, Prof. Dayton C., Case School of Applied Science, Cleveland, Ohio. (44). 1898. B

MILLER, EDGAR G., 213 E. German St., Baltimore, Md. (29). A E F

*Miller, Edmund H., Ph. D., Columbia University, New York, N. Y (50). 1901. C

Miller, Emerson R., Santiago de las Vegas, Cuba. (52). C

*Miller, Ephraim, Professor of Mathematics and Astronomy, State University, Lawrence, Kan. (50). 1901. A

Miller, Frank E., Professor of Mathematics, Otterbein University Westerville, Ohio. (44). A

Miller, Capt. Frederick Augustus, U. S. N., 2201 Massachusetts Ave., Washington, D. C. (52).

*Miller, Fred. J., Editor of "American Machinist," 34 Beech St., E. Orange, N. J. (51). 1906. **D**

*Miller, George A., Ph. D., Stanford University, Cal. (46). 1898. **A**

Miller, George N., M. D., 811 Madison Ave., New York, N.Y. (50). **K**

*Miller, Gerrit S., U. S. National Museum, Washington, D. C. (51). 1906. **F**

Miller, Henry Huntington, Mgr. Balsas Valley Co., Hanover Bank Bldg., New York, N. Y. (50). **C D E**

Miller, Herbert Stanley, Electrical Engineer, 1025 East Jersey St., Elizabeth, N. J. (50). **D**

Miller, Horace George, M. D., 189 Bowen St., Providence, R. I. (51). **K**

Miller, James Shannon, Professor of Mathematics, Emory and Henry College, Emory, Va. (51). **A B**

*Miller, John A., Professor of Mechanics and Astronomy, Indiana University, Bloomington, Ind. (51). 1906. **A**

*Miller, J. Craig, M. D., Professor of Natural Science, Lincoln University, Pa. (50). 1906. **B C F K**

Miller, Louallen F., Instructor in Physics, University of Wisconsin, Madison, Wis. (53). **B**

*Miller, Miss Louise Klein, 371 Euclid Ave., Cleveland, Ohio. (50). 1906. **I**

Miller, Loye Holmes, State Normal School, Los Angeles, Cal. (53). **F**

Miller, Thomas David, C. E., Engineer and General Manager of New Orleans Lighting Co., New Orleans, La. (55). **D**

*Miller, Prof. William S., University of Wisconsin, Madison, Wis. (42). 1894. **F**

*Millis, John, Major of Engineers, U. S. A., U. S. Engineer's Office, Manila, P. I. (48). 1906. **A B D E**

Mills, Frank Smith, Dept. of Geology and Biology, St. Lawrence University, Canton, N. Y. (52). **E**

Mills, James Edward, Instructor in Physical Chemistry, University of North Carolina, Chapel Hill, N. C. (52).

*Mills, Prof. Wesley, McGill University, Montreal, Can. (31). 1886. **F H**

*Mills, William C., Page Hall, Ohio State University, Columbus, Ohio. (48). 1902. **H**

Mills, Wm. Park, M. D., Missoula, Mont. (52).

MILNE, DAVID, 2030 Walnut St., Philadelphia, Pa. (51).

*Miner, J. Burt, Ph. D., State University of Iowa, Iowa City, Iowa. (52). 1906. **H K**

Minns, Miss S., 14 Louisburg Square, Boston, Mass. (32).

*MINOT, CHARLES SEDGWICK, M. D., Harvard Medical School, Boston, Mass. (28). 1880. **F**

Mitchell, Andrew S., Analytical and Consulting Chemist, State Analyst, 220 Greenbush St., Milwaukee, Wis. (51). **C**

Mitchell, Edward, 44 Wall St., New York, N. Y. (50).

Mitchell, Evelyn Groesbeek, 813 T St., N.W., Washington, D. C. (54). **F**

Mitchell, Guy E., Am. Mutual Newspaper Assn. Evening Star Bldg., Washington, D. C. (53). **I**

*Mitchell, Henry Bedinger, Tutor in Mathematics, Columbia University, New York, N. Y. (50). 1906. **A**

Mitchell, J. Pearce, Stanford University, Cal. (51). **C**

Mitchell, Roland G., 17 Battery Place, New York, N. Y. (50).

*Mitchell, S. Alfred, Ph. D., Columbia University, New York, N. Y. (52). 1906. **A B**

Mitchell, Walter Mann, 112 N. 34th St., Philadelphia, Pa. (54). **A**

Mitchell, William Francis, M. D., Lancaster, Mo. (51). **K**

Mixer, Chas. Adam, Civil Engineer, Resident Engineer, Rumford Falls Power Co., Rumford Falls, Maine. (51). **D**

Mixer, Fred. K., 313 Delaware Ave., Buffalo, N. Y. (35). **E**

*Miyake, Kiichi, Ph. D., Doshisha College, Kioto, Japan. (51). 1903. **G**

*Moenkhaus, Wm. J., University of Indiana, Bloomington, Ind. (51). 1903. **F**

Mohler, George H., Fremont Normal School, Fremont, Neb. (53). **B F**

*Mohler, John F., Professor of Physics, Dickinson College, Carlisle, Pa. (44). 1905. **B**

Mohr, Charles, M. D., Professor of Materia Medica and Therapeutics, Hahnemann Medical College and Hospital, Philadelphia, Pa. (51). **K**

Mohr, Louis, M. E., 32 Illinois St., Chicago, Ill. (50). **A D**

Mojonnier, Timothy, care of Helvetia Milk Condensing Co., Delta, Ohio. (52). **C**

*Moler, Geo. S., 106 University Ave., Ithaca, N. Y. (38). 1892. **B**

Molera, E. J., Civil Engineer, 606 Clay St., San Francisco, Cal. (50). **D**

Molitor, David, Civil and Consulting Engineer, 25 N. Park Ave., Fond du Lac, Wis. (51). **C D**

Molitor, Frederic Albert, Supervising Railway Expert, Philippine Government, Manila, P. I. (51). **D**

Momsen, Hart, Chief Clerk, Div. of Agric. Census Office, Washington, D. C. (50). **I**

Monfort, Wilson F., Chemist to Water Comm., 3810 Delmar Bldg., St. Louis, Mo. (48). **C**

Monroe, Joseph E., Professor of Physics and Chemistry, Montana State Normal College, Dillon, Mont. (50). **B C**

*Monroe, Will S., Professor of Psychology and Pedagogy, State Normal School, Westfield, Mass. (49). 1901. H

*Montague, William Pepperell, Dept. of Philosophy and Psychology, Columbia University, New York, N. Y. (54). 1906. H I

Montgomery, Edmund, M. D., Hempstead, Texas. (50). F K

Montgomery, Edmund B., M. D., 134 W. 8th St., Quincy, Ill. (51). K

Montgomery, Henry, Ph. D., Professor of Geology and Biology, Trinity College, Toronto, Ontario, Canada. (54). E F H

*Moody, Mrs. Agnes Claypole, 125 Belvedere St., San Francisco, Cal. (46). 1899. F

Moody, Mrs. Mary B., M. D., 165 So. Marengo Ave., Pasadena, Cal. (25). E F

*Moody, Robert O., M. D., Hearst Anatomical Laboratory, San Francisco, Cal. (35). 1892. F

*Moody, William Albion, Professor of Mathematics, Bowdoin College, Brunswick, Maine. (50). 1906. A

Mooers, Charles Ansel, Univ. of Tennessee, Knoxville, Tenn. (55). C

Mooney, James, Bureau of Ethnology, Washington, D. C. (54). H

Moore, Andrew Charles, Prof. Biol. and Geol. S. C. College, Columbia, S. C. (54). E F

Moore, Mrs. A. H., Stanstead, P. Q., Canada. (32). H

*Moore, Burton E., University of Nebraska, Lincoln, Neb. (41). 1899. B

*Moore, Clarence B., 1321 Locust St., Philadelphia, Pa. (44). 1897. H

*Moore, Eliakim Hastings, Professor of Mathematics, University of Chicago, Chicago, Ill. (52). 1902. A

Moore, Ernest Carroll, Ph. D., Instructor in Philosophy, University of California, Berkeley, Cal. (50). I

*Moore, George Thomas, Cosmos Club, Washington, D. C. (49). 1901. G

*Moore, J. Percy, Ph. D., Instructor in Zoology, Biological Hall, Univ. of Pa., Philadelphia. (54). 1906. F

*Moore, J. W., M. D., Lafayette College, Easton, Pa. (22). 1874. A B D

*Moore, Philip North, Geologist and Mining Engineer, 121 Laclede Bldg., St. Louis, Mo. (50). 1903. E

Moore, Robert, Consulting Engineer, 61 Vandeventer Place, St. Louis, Mo. (51). D

Moore, Stanley H., McKinley High School, St. Louis, Mo. (50). A D

*Moore, Prof. Willis L., Chief of the Weather Bureau, U. S. Dept. Agriculture, Washington, D. C. (44). 1897. B

*Moorehead, Warren K., Curator of Museum, Phillips Academy, Andover, Mass. (38). 1890. H

Morgan, A. C., U. S. Dept. Agriculture, Washington, D. C. (54). F

Morgan, J. Frank, Agr. Exper. Station, Kingston, R. I. (55). C

*Morgan, H. A., Director Agric. Exper. Station, Knoxville, Tenn. (50). 1906. F

*Morgan, T. Hunt, Ph. D., Prof. of Zoology, Columbia University, New York, N. Y. (54). 1906. F

*Morgan, Wm. Conger, Ph. D., Instructor in Chemistry, University of California, Berkeley, Cal. (52). 1906. C

Morgan, Wm. F., Short Hills, N. J. (27).

Morgan, William Henry, President of The Morgan Engineering Co. Alliance, Ohio. (54). D

*Morley, Prof. Edward W., Adelbert College, Cleveland, Ohio. (18). 1876. B C E

Morrey, Charles B., Ohio State University, Columbus, Ohio. (48). F

*Morrill, Austin W., Ph. D., U. S. Dept. Agriculture, Washington, D. C. (54). 1906. F

Morris, Edward Lyman, Washington High School, Washington, D. C. (52). G

Morris, F. W., Villa Nova, Pa. (51).

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Morris, Robert C., Clerk of Wyoming Supreme Court, Cheyenne, Wyoming. (51). I

Morris, Russell Love, Professor of Civil and Mining Engineering, West Virginia State University, Morgantown, W. Va. (50). D

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*Morse, E. S., Salem, Mass. (18). 1874. F H

*Morse, Fred. W., Prof. of Organic Chemistry, New Hampshire College, Durham, N. H. (51). 1906. C

Morse, Max W., Dept. of Zoology, Columbia Univ., New York, N. Y. (51). F

Morse, Warner Jackson, Instructor in Botany, University of Vermont, Burlington, Vt. (52). G

Morse, Willard S., Apartado "A," Aguascalientes, Mexico. (50). C D E

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*Moser, Jefferson F., Captain U. S. N., Retired, care Alaska Packers Assn., 49 2d St., San Francisco, Cal. (28). 1889. **E**
*Moses, Prof. Alfred J., Columbia University, New York, N. Y. (49). 1902. **E**
Mosher, Charles D., care of Mosher Water Tube Boiler Co., 1 Broadway, New York, N. Y. (53). **D**
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Motter, Murray Galt, M. D., Professor of Physiology, Georgetown University Medical School. Washington, D. C. (51). **K**
*Mottier, David M., Ph. D., Professor of Botany, University of Indiana, Bloomington, Ind. (50). 1901. **F G K**
*Moulton, Forest Ray, Ph. D., Instructor in Celestial Mechanics, University of Chicago, Chicago, Ill. (50). 1901. **A**
Moulton, W. H., care Cleveland Cliffs Iron Co., Ishpeming, Mich. (53). **D**
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Moyer, Lycurgus R., C. E., Montevideo, Minn. (50). **D G**
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Mueller, Edward, Assistant Chemist, N. & W. R. R., 519 N. Mich. St., South Bend, Ind. (52). **C**
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Mulford, Miss A. Isabel, McKinley High School, St. Louis, Mo. (45). **G**
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*Mulliken, Samuel P., Mass. Inst. Technology, Boston, Mass. (43). 1899.
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Munroe, John P., M. D., President N. C. Medical College, Davidson, N. C. (53). **K**
Munson, Joseph Theodore, Denison, Texas. (55). **C E**
Munson, T. V., Nurseryman, Denison, Texas. (51). **G**
Munson, W. H., Teacher of Zoology State Normal School, Winona, Minn. (54). **F**

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Myres, John L., M. A., F. S. A., Christ Church, Oxford, England. (46). H

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Nancrede, Charles Beylard, Prof. of Surgery, University of Mich. Ann Arbor, Mich. (54). K

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*Neal, Herbert V., Knox College, Galesburg, Ill. (53). 1905. F

*Needham, Dr, James G., Lake Forest College, Lake Forest, Ill. (45). 1898. F

Needham, John B., Jr., Salem Public School, Salem, Mo. (54).

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Neilson, Walter Hopper, M. D., Ed. "Milwaukee Medical Journal," 114 Garfield Ave., Milwaukee, Wis. (51). K

*Nelson, Aven, Professor of Biology, University of Wyoming, Laramie, Wyoming. (50). 1903. G

*Nelson, Prof. A. B., Centre College, Danville, Ky. (30). 1882. **A B D**

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*Newell, William Wells, Editor "Journal American Folk Lore," Cambridge, Mass. (41). 1893. **H**

*Newell, Wilmon, Secretary Crop Pest Commission, Shreveport, La. (53). 1906. **F G**

Newland, David Hale, Asst. State Geologist, The State Museum, Albany, New York. (54). **E**

*Newsom, John F., Stanford University, Cal. (44). 1903. **E**

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*Nolan, Edw. J., M. D., Acad. Nat. Sciences, Philadelphia, Pa. (29). 1890. F

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*Norris, James F., Prof. of Chemistry, Simmons College, Boston, Mass. (54). 1906. C

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Norton, A. Wellington, LL. D., Madison, S. Dak. (52). I

Norton, J. B., Dept. of Agriculture, Washington, D. C. (52). G

*Norton, J. B. S., College Park, Md. (47). 1899. G

*NORTON, THOMAS H., U. S. Consul, Smyrna, Turkey in Asia, via England. (35). 1887. C

*Norwood, Charles Joseph, Professor of Mining State A. and M. College, Lexington, Ky. (54). 1906. E

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*Noyes, Prof. Arthur A., Mass. Inst. Technology, Boston, Mass. (45). 1897. C

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*Nutting, Perley Gilman, National Bureau of Standards, Washington, D. C. (53). 1906. A

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O'Donoghue, Rev. Martin, Ammendale, Md. (53). K

Oestlund, Oscar W., Entomologist, State University, Minneapolis, Minn. (50). F

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O'Harra, Prof. Cleophas Cisney, State School of Mines, Rapid City, So. Dak. (49).

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O'Kane, Henry, Wyandotte Bldg., Columbus, Ohio. (55) I

Oldberg, Oscar, Prof. of Pharmacy and Applied Phar. Chemistry, Northwestern University Bldg., Chicago, Ill. (54). C

Oldfield, Anthony M., M. D., Harbor Beach, Mich. (51). K

Olds, George D., Dept. Mathematics, Amherst College, Amherst, Mass. (54). A

Oleson, Olaf M., Fort Dodge, Iowa. (53). C G

*Oliphant, F. H., Geologist of South Penn. Oil Co., Oil City, Pa. (51). 1906. E

*Olive, Edgar W., University of Wisconsin, Madison, Wis. (48). 1903. G

*Oliver, Charles A., M. D., 1507 Locust St., Philadelphia, Pa. (54). 1905. F

Olmsted, John Charles, Landscape Architect, 16 Warren St. Brookline, Mass. (50). E I

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Olsson-Seffer, Pehr, Ph. D. La Zacualpa Botanical Station or Rubber Laboratory, Escuintla, Chiapas, Mexico. (55).

Onderdonk, Henry U., M. D., Buffalo, Wyo. (51). G K

Opdyke, William S., 20 Nassau St., New York, N. Y. (49).

*Orleman, Col. Louis H., Ph. D., Principal Peekskill Military Academy, Peekskill, N. Y. (47). 1900.

Orr, William, Jr., 30 Firglade Ave., Springfield, Mass. (39). 1895. B F

*Ortmann, Arnold Edward, Ph. D., Curator of Invertebrate Zoology, Carnegie Museum, Pittsburg, Pa. (51). 1903. E

*Orton, Edward, Jr., The Normandie, Columbus, Ohio. (48). 1900. E
*Orton, W. A., Div. of Veg. Phys. and Path., U. S. Dept. Agriculture, Washington, D. C. (49). G
Osborn, Frederick A., Professor of Physics, University of Washington. Seattle, Wash. (50). B
*Osborn, H. L., Professor of Zoology, Hamline University, St Paul, Minn. (52). 1906. F
*Osborn, Henry F., Columbia University, New York, N. Y. (29). 1883. F
*Osborn, Herbert, Ohio State University, Columbus, Ohio. (32). 1884. F
*Osborne, George Abbott, Professor of Mathematics, Mass. Inst. of Technology, Boston, Mass. (50). 1903. A
Osborne, Loyall Allen, E. E., Mgr. of Works of Westinghouse Electric and Mfg. Co., Pittsburg, Pa. (50). D
*Osburn, Raymond Carroll, Department of Zoology, Columbia University, New York, N. Y. (50). 1906. F
Osgood, Joseph B. F., P. O. Box 212, Salem, Mass. (31).
*Osgood, Wilfred H., U. S. Department of Agriculture, Washington, D. C. (52). 1905. F
O'Shea, Prof. M. V., Secretary of the Society of College Teachers of Education, University of Wisconsin, Madison, Wis. (53). I
*Osmond, Prof. I. Thornton, State College, Pa. (33). 1889. A B C
O'Sullivan, Rev. Denis T., S. J., 761 Harrison St., Boston, Mass. (40). A B
*Ott, Isaac, 18 N. 4th St., Easton, Pa. (54). 1906. K
*Overton, James Bertram, Ph. D., Instructor in Botany, Univ. of Wisconsin, Madison, Wis. (52). 1906. G
*Owen, Charles Lorin, Field Columbian Museum, Chicago, Ill. (50). 1902. H
Owen, Prof. D. A., Franklin, Ind. (34). E
Owen, Frederick Denison, No. 3 Grant Place, Washington, D. C. (52). D
*Owen, Miss Juliette A., 306 N. Ninth St., St. Joseph, Mo. (50). 1906. F
Owen, Miss Luella Agnes, 306 N. Ninth [St.,] St. Joseph, Mo. (47). E
Owens, William Gundy, Professor of Chemistry and Physics, Bucknell University, Lewisburg, Pa. (50). B C
Pack, Fred J., Woods Cross, Utah. (54). E
Packard, George Arthur, Metallurgist and Mining Engineer, 18 Lafayette St., Wakefield, Mass. (50). E
*Paddock, Wendell, Professor of Botany and Horticulture, Agricultural College, Fort Collins, Colo. (50). 1901. G

PAGE, CLARENCE V., Civil and Mining Engineer, P. O. Box 922, Butte, Montana. (51). D E

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*Paine, Robert Treat, President, Associated Charities of Boston, 6 Joy St., Boston, Mass. (50). 1903. I

Painter, Joseph H., U. S. National Museum, Washington, D. C. (54). G

*Palmer, Prof. Albert De Forest, Brown University, Providence, R. I. (47). 1900. B

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Palmer, Dr. Edward, Botanical Div., U. S. Dept. Agriculture, Washington, D. C. (22). H

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Palmer, Thomas Waverly, Professor of Mathematics, University of Alabama, University, Ala. (55). A

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Parmelee, Horatio P., Charlevoix, Mich. (42). E H

Parr, Samuel Wilson, Professor of Applied Chemistry, University of Illinois, Urbana, Ill. (55). C

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Parsons, Francis H., 210 1st St., S.E., Washington, D. C. (52).

PARSONS, JOHN E., 111 Broadway, New York, N. Y. (36).

Pastorius, C. Sharpless, care of Van Briggle Pottery Co., Colorado Springs, Colo. (51).

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Patrick, Edward T., Drawer C, Goldfield, Nev. (54). G I

Patrick, Frank, 601 Kansas Ave., Topeka, Kansas. (50).

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Patten, Frank Chauncy, Librarian, Rosenberg Library, Galveston, Texas. (53). I

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*Patterson, Dr. A. M., 57 Clarendon St., Springfield, Mass. (51). 1906. C

Patterson, Mrs. Flora Wambaugh, U. S. Dept. Agriculture, Washington, D. C. (44). G

*Patterson, George W., Jr., 814 S. University Ave., Ann Arbor, Mich. (44). 1896. B

*Patterson, Harry J., College Park, Md. (36). 1890. C

*Patterson, Prof. James L., Chestnut Hill, Philadelphia, Pa. (45). 1906.

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Peck, Frederick B., Lafayette College, Easton, Pa. (49).

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Perkins, Henry Farnham, Ph. D., University of Vermont, Burlington, Vt. (52). **F**

Perkins, John Walter, M. D., 423 Altman Building, Kansas City, Mo. (51). **K**

*PERRINE, C. D., Asst. Astronomer, Lick Observatory, Mt. Hamilton, Cal. (51). 1903. **A**

Perrine, Miss Lura L., State Normal School, Valley City, No. Dak. (47). **E F G H**

*Perry, Arthur C., 226 Halsey St., Brooklyn, N. Y. (43). 1896. **A B**

Pomeroy, Charles Taylor, 55 Broad St., Newark, N. J. (43).
*Pond, Francis J., Stevens Institute of Technology, Hoboken, N. J. (54). 1906. C
*Pond, G. Gilbert, Ph. D., Professor of Chemistry, State College, Pa. (51). 1903. C
*Pond, Raymond Haines, Ph. D., Northwestern University Bldg., Chicago, Ill. (52). 1905. G
Poor, Charles L., Professor of Astronomy, Columbia University, New York, N. Y. (55). A B
*Poor, John Merrill, Professor of Astronomy, Dartmouth College, Hanover, N. H. (52). 1906. A
*Porter, Albert B., 1232 Forest Ave., Evanston, Ill. (53). 1906. B
Porter, Miss Caroline Johnson, 1820 Rittenhouse Square, Philadelphia, Pa. (52).
Porter, Miss Edna, 94 Russell Ave., Buffalo, N. Y. (41). F G
Porter, Fred. B., 4911 Champlain Ave., Chicago, Ill. (52). C
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Porter, Henry K., Trustee of Carnegie Institute, 541 Wood St., Pittsburg, Pa. (50). D
Porter, J. Edward, Mfg. Chemist and Analyst, P. O. Box 785, Syracuse, N. Y. (50). C
*Porter, Royal A., Instructor in Physics, Syracuse University, Syracuse, N. Y. (54). 1906. B
*Porter, W. Townsend, M. D., Assistant Professor of Physiology, Harvard Medical School, Boston, Mass. (50). 1901. K
Posse, Baroness Rose, Posse Gymnasium, 206 Massachusetts Ave., Boston, Mass. (52).
*Post, Charles A., Bayport, Long Island, N. Y. (49). 1901. A
Post, Walter A., General Superintendent, Newport News Shipbuilding and Dry-dock Co., Newport News, Va. (51). D
Poteat, Wm. L., Wake Forest, N. C. (47). F
Poth, Harry A., Technical Brewer, 216 N. 33d St., Philadelphia, Pa. (53). G
Potter, Richard B., M. D., West Palm Beach, Fla. (51). K
*Potter, William Bancroft, Chief Engineer, Ry. Dept. G. E. Co., Schenectady, N. Y. (50). 1906. D
Potts, Howard Newcomb, 466 N. 7th St., Philadelphia, Pa. (54).
*Potts, Louis Maxwell, Ph. D., Constructing Engineer, The Rowland Telegraphic Co., 107 E. Lombard St., Baltimore, Md. (54). 1906. D
*Pound, Roscoe, Univ. of Nebraska, Lincoln, Nebr. (54). 1906.
Powell, Colonel de Veaux, 29 Broadway, New York, N. Y. (50).

Powell, Frederick James, 331 E. 17th St., New York, N. Y. (54). **A B D**

Powell, James, Mechanical Engineer, 2525 Spring Grove Ave., Cincinnati, Ohio. (51). **D**

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*Power, Frederick B., Ph. D., Director, The Wellcome Research Laboratories, 6 King St., Snow Hill, London, E. C., England. (31). 1887. **C**

*Powers, Le Grand, 3107 16th St., N. W., Washington, D. C. (51). 1902. **I**

Praeger, William Emilius, Kalamazoo College, Kalamazoo, Mich. (53). **G**

Prang, Louis, 45 Centre St., Roxbury, Mass. (29). **D**

Prather, John McClellan, Ph. D., Instructor in Biology, St. Louis High School, St. Louis, Mo. (52). **F**

Pratt, Alexander, Jr., Ph. D., 26 Bunnell St., Bridgeport, Conn. (50). **H I**

Pratt, John Francis, Coast Survey, Washington, D. C. (54). **A**

*Pratt, Joseph Hyde, Ph. D., Chapel Hill, N. C. (49). 1902. **E**

Pratt, Brig. Gen. R. H., 1304 Corona St., Denver, Colo. (53). **I**

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*Prescott, Samuel Cate, Instructor in Biology, Mass. Inst. Tech., Boston, Mass. (51). 1906. **K**

Price, Harvey Lee, Adjunct Professor of Horticulture, Agricultural Experiment Station, Blacksburg. Va (52). **G**

Price, Robert Henderson, Willow View Farm, Long's Shop, Va. (50). **F G**

Price, Thomas Malcolm, U. S. Dept. of Agriculture Washington, D. C. (50). **C**

Priest, Henry, Ph. D., Dean of College of Letters and Science, St. Lawrence University, Canton, N. Y. (53). **I**

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Prindle, Louis Marcus, Geological Survey, Washington, D. C. (55). **E**

Pritchard, Myron T., 125 School St., Roxbury, Mass. (52). **E I**

Pritchard, William Broaddus, M. D., 105 W. 73d St., New York, N. Y. (51). **K**

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Probasco, John Buck, M. D., 175 E. Front St., Plainfield, N. J. (51). **K**

*Proctor, Chas. A., Department of Physics, University of Missouri, Columbia, Mo. (53). 1906. **B**

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Proffitt, Max J., Gunnison, Colo. (55). F
*Prosser, Charles S., Ohio State Univ., Columbus, Ohio. (33). 1891. E F
Proudfit, Alexander Couper, 105 E. 22d St., New York, N. Y. (47).
Provine, John William, Prof. Chemistry, Mississippi College, Clinton, Miss. (54). C
PRUYN, JOHN V. L., JR., Albany, N. Y. (29).
Pryer, Charles, New Rochelle, N. Y. (49).
Puffer, William L., 198 Mt. Vernon St., West Newton, Mass. (50). D
*PUPIN, DR. M. I., Columbia University, New York, N. Y. (44). 1896. B
*Purdue, Albert Homer, Professor of Geology, University of Arkansas, Fayetteville, Ark. (50). 1906. E
*Puryear, Chas., Professor of Mathematics, Agric. and Mech. College, College Station, Tex. (51). 1906. A
Pusey, Wm. Allen, M. D., 512 Greenwood Bvd., Evanston, Ill. (54). B F G
Putnam, Chas. P., M. D., 63 Marlborough St., Boston, Mass. (28).
Putman, Miss Elizabeth D., Treasurer, Davenport Academy of Sciences, Davenport, Iowa. (45).
*Putnam, Prof. F. W., Peabody Museum, Cambridge, Mass. (10). 1874. H
Putman, Henry St. Clair, 100 Broadway, New York, N. Y. (47).
Pyle, Miss Effie B., Principal of High School, Coldwater, Kansas. (51). B C
Pyle, William Henry, Supt. Vandalia City Schools, Vandalia, Ill. (53). I
Quackenbos, John D., M. D., 331 W. 28th St., New York, N. Y. (49).
*Quaintance, A. L., U. S. Department of Agriculture, Washington, D. C. (51). 1903. F
Quarles, James A., L. L. D., Professor of Philosophy, Washington and Lee University, Lexington, Va. (55). I K
Quayle, H. J., Assistant Entomologist, Experiment Station, Ames, Iowa. (55). F
*Quinn, John James, Warren, Pa. (52). 1905. A
Quiroga, Modesto, Cornell University, Ithaca, N. Y. (52).
Radin, Paul, 844 Teasdale Place, New York, N. Y. (52). F K
*Ramaley, Francis, University of Colorado, Boulder, Colo. (45). 1899. G
Ramsey, Miss Mary C., Shoshone Agency, Wyoming. (52). H
*Ramsey, Rolla Roy, Associate Professor of Physics, Indiana University, Bloomington, Ind. (50). 1906. B

Ramsey, Rolla Roy, 615 E. 3d St., Bloomington, Ind. (50). **B**

Ranck, Samuel Haverstick, Librarian, Ryerson Pub. Library, Grand Rapids, Mich. (54). **I**

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Randall, John E., Superintendent and Electrical Engineer, Columbia Inc. Lamp Co., St. Louis, Mo. (50). **D**

Randolph, Beverley S., Civil and Mining Engineer, Berkeley Springs, West Va. (50). **D E**

*Rane, F. Wm., New Hampshire Agric. Exper. Station, Durham, N. H. (42). 1900. **G**

Rankin, H. D., 708 Railroad St. Joliet. Ill., (54).

*Rankin, Walter M., Professor of Invertebrate Zoology, Princeton University, Princeton, N. J. (51). 1905. **F**

Ransohoff, Joseph, M. D., Cincinnati, Ohio. (51). **K**

Ransom, James Harvey, Ph D., Assoc. Prof. Chemistry, Purdue Univ., Lafayette, Ind. (54). **C**

*Ransome, Frederick Leslie, Ph. D., U. S. Geological Survey, Washington, D. C. (52). 1903. **E**

Rathbun, John Charles, Tung Wen Institute, Amoy, China (53). **A**

*Rathbun, Miss Mary J., Smithsonian Institution, Washington, D. C. (52). 1906. **F**

*Rathbun, Richard, Smithsonian Institution, Washington, D. C. (40). 1892. **F**

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Raymer, George Sharp, Instructor in Mining, Harvard University, Cambridge, Mass. (50). **D E**

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Rea, Paul M., Professor of Biology and Geology, College of Charleston, Charleston, S. C. (53). **E F**

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Reagan, Albert B., Indian School Service, Mora, Wash. (53). **E**

Reber, Samuel, Lieut. Col. U. S. A., Army War College, Washington, D. C. (50). **D**

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Redding, Allen C., Tybo, Nevada. (39). **C**

*Reed, Charles J., 3313 N. 16th St., Philadelphia, Pa. (34). 1903. **B C**

Reed, Howard Sprague, Instructor in Botany, University of Missouri, Columbia, Mo. (53). **G**

*Reed, Hugh D., Ph. D., Instructor, Dept. of Neurology, Vertebrate Zoology and Physiology, Cornell University, Ithaca, N. Y. (49). 1906. **F**

Reed, Hon. James H., Amberson Ave., Pittsburg, Pa. (51).

*Reed, John O., 907 Lincoln Ave., Ann Arbor, Mich. (44). 1898. **B**

*Rees, Prof. John K., Columbia University, New York, N. Y. (26). 1878. **A B E**

*Reese, Albert Moore, Ph. D., Syracuse University, Syracuse, N. Y. (52). 1906. **F**

*Reese, Charles L., 1020 Jackson St., Wilmington, Del. (39). 1892. **C**

*Reese, Herbert M., 701 Maryland Place, Columbia, Mo. (49). 1906. **B**

*Reese, Jacob, Dayton, Fla. (33). 1891. **B D**

*Reichmann, Fritz, Troy, N. Y. (54). 1906. **B**

*Reid, Harry Fielding, Johns Hopkins University, Baltimore, Md. (36). 1893. **B**

*Reid, Hon. Whitelaw, 451 Madison Ave., New York, N. Y. (50). 1901. **I**

Reifsnyder, Samuel K., 705 Bond St., Asbury Park, N. J. (50). **I**

Reigart, John Franklin, 31 Euclid Ave., Yonkers, N. Y. (53). **I**

*Reighard, Jacob, Prof. of Zoology, Univ. of Michigan, Ann Arbor, Mich. (51). 1903. **F**

Reist, Henry G., Mechanical and Electrical Engineer, 5 South Church St., Schenectady, N. Y. (50). **D**

*Remington, Prof. Joseph Price, 1832 Pine St., Philadelphia, Pa. (54). 1906. **K**

*Remsen, Ira, President Johns Hopkins University, Baltimore, Md. (22). 1875. **C**

Renninger, John S., M. D., Marshall, Minn. (31). **C F**

Reynolds, Dudley Sharpe, M. D., 304 W. Chestnut St., Louisville, Ky. (50). **K**

Reynolds, George, P. O. Box B, Salt Lake City, Utah. (44). **H**

*Rhodes, James Ford, Author and Historian, 392 Beacon St., Boston, Mass. (50). 1903. **I**

Rice, Calvin Winsor, Consulting Engineer, General Electric Co., 44 Broad St., New York, N. Y. (51). **B D**

*Rice, Edward L., A. B., Ohio Wesleyan University, Delaware, Ohio. (43). 1905. **F**

Rice, Edwin Wilbur, Jr., General Electric Co., Schenectady, N. Y. (50). D

Rice, Herbert A., Assistant Professor of Civil Engineering, University of Kansas, Lawrence, Kansas. (55). A D

*Rice, Martin Everett, Asst. Professor of Physics and Electrical Engineering, University of Kansas, Lawrence, Kans. (50). 1906. B D

*Rice, Prof. W. North, Wesleyan University, Middletown, Conn. (18). 1874. E F

Rich, Michael P., M. D., 50 W. 38th St., New York, N. Y. (40).

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*Richards, Charles B., 227 Edwards St., New Haven, Conn. (33). 1885. D

*RICHARDS, EDGAR, 341 W. 88th St., New York, N. Y. (31). 1886. C

*Richards, Herbert Maule, Ph. D., Instructor in Botany, Barnard College, Columbia University, New York, N. Y. (51). 1902. G

*Richards, Prof. Robert H., Mass. Institute of Technology, Boston, Mass. (22). 1875. D

*Richards, Mrs. Robert H., Mass. Institute of Technology, Boston, Mass. (23). 1878. C

*Richards, Prof. Theodore William, Harvard University, Cambridge, Mass. (47). 1899.

Richardson, Major Charles A., Canandaigua, N. Y. (50). I

*Richardson, Charles Henry, Ph. D., Department of Mineralogy, Dartmouth College, Hanover, N. H. (47). 1906. C E

Richardson, Charles Williamson, M. D., 1317 Connecticut Ave., N. W., Washington, D. C. (49).

*Richardson, Clifford, Barber Asphalt Paving Co., 122 E. 34th St. New York, N. Y. (30). 1884. C

Richardson, G. B., U. S. Geological Survey, Washington, D. C. (55).

*Richardson, Miss Harriet, 1864 Wyoming Ave., Washington, D. C. (49). 1903. F.

Richardson, Leon B., 3443 Chestnut St., Philadelphia, Pa. (52). C

*Richardson, Mark Wyman, M. D., 90 Equitable Building, Boston, Mass. (51). 1903. K

Richardson, Wm. D., P. O. Box 185, Fredericksburg, Va. (52). C F

Richey, Stephen O., Ph. D., 732 17th St., Washington, D. C. (54).

Richmond, William Henry, 3425 North Main Ave., Scranton, Pa. (50). E

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*Rickard, T. A., Editor of Mining and Scientific Press, 330 Market St., San Francisco, Cal. (50). 1906. D E

Ricker, Maurice, Principal of High School, Burlington, Iowa. (50). F

*Ricker, N. Clifford, Dean of the College of Engineering, University of Illinois, Urbana, Ill. (50). 1906. D

*Ricker, Percy Leroy, Department of Agriculture, Washington, D. C. (52). 1906. G

Ricketts, Louis D., Consulting Mining Engineer, Globe, Arizona. (50). D E

*Ricketts, Palmer C., President Rensselaer Polytechnic Institute, Troy, N. Y. (33). 1887. A D

*Ricketts, Prof. Pierre de Peyster, 104 John St., New York, N. Y. (26). 1880. C D E

Ricketts, Col. R. Bruce, Wilkesbarre, Pa. (33). E

Riddle, Lincoln Ware, 61 Brattle St., Cambridge, Mass. (52). G

Riddle, Lumina C., 160 West Fifth Ave., Columbus, Ohio. (48). G

Ries, Elias E., E. E., 116 Nassau St., New York, N. Y. (33). B D

*Ries, Heinrich, Ph. B., Ithaca, N. Y. (41). 1898. E

Riesman, David, M. D., 1624 Spruce St., Philadelphia, Pa. (51). K

*Rietz, Henry Lewis, University of Illinois, Urbana, Ill. (51). 1906. A

Riggs, Norman Colman, Assoc. Prof. Mathematics, Armour Inst. of Tech., Chicago, Ill. (54). A

*Riggs, Robert Baird, Ph. B., Professor of Chemistry, Trinity College, Hartford, Conn. (50). 1901. C

Riker, Clarence B., Maplewood, N. J. (52). F

Riker, Samuel, 27 E. 69th St., New York, N. Y. (50).

Riley, Cassius M., Professor of Chemistry, Barnes Medical College and Barnes College of Pharmacy, St. Louis, Mo. (53). C

*Riley, Isaac Woodbridge, Ph. D., Johns Hopkins Univ., Baltimore, Md. (52). 1903. H I

Riley, Mrs. Matilda E., Art Director, St. Louis Public Schools, Board of Education Building, St. Louis, Mo. (53).

Riley, William Albert, Ph D., Instructor in Entomology, Cornell University, Ithaca, N. Y. (54). F

Rissmann, Otto, General Manager, Cockerill Zinc Co., Nevada, Mo. (50). D E

Ritchie, Craig D., Conveyancer, 414 N. 34th St., Philadelphia, Pa. (51).

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Roark, Ruric Nevel, Clark University, Worcester, Mass. (54). I

Robb, Hunter, M. D., 702 Rose Building, Cleveland, Ohio. (51).

Robb, J. Hampden, 23 Park Ave., New York, N. Y. (50).

Robert, Henry Martyn, Brig.-Gen., U. S. A., 5022 Cedar Ave., Philadelphia, Pa. (54). D I

Robert, Dr. J. C., A.and M. College, Agricultural College, Miss.(51).
Roberts, H. L., Department of Biology, Western Illinois State Normal School, Macomb, Ill. (52). **F**
Roberts, Miss Jennie B., 231 William St., Port Chester, N. Y. (43).
Roberts, Milnor, Professor of Mining and Metallurgy, University of Washington, Seattle, Wash. (50). **D E**
Roberts, Thomas Paschall, Civil Engineer, 361 North Craig St., Pittsburg, Pa. (51). **D**
Roberts, Wm. F., 730 15th St., Washington, D. C. (52). **F I**
Robertson, Alice, Assistant in Zoology, University of California, Berkeley, Calif. (54). **F**
*Robertson, Charles, Carlinville, Ill. (53). 1906. **F**
*Robinson, Benjamin Lincoln, Curator Harvard Herbarium, Cambridge, Mass. (41). 1893. **G**
*Robinson, Mrs. Daisy M. Orleman, M. D., 159 W. 49th St., New York, N. Y. (40). 1897. **F K**
*Robinson, Prof. Franklin C., Bowdoin College, Brunswick, Me. (29). 1889. **C D**
*Robinson, Otis Hall, Professor of Natural Philosophy, University of Rochester, Rochester, N. Y. (23). 1901. **A B**
Robinson, Samuel Adams, M. D., Covesville, Va. (51). **H I K**
Robinson, Sanford, C. E., E.M., Steeple Rock, New Mexico. (50). **D**
*Robinson, Prof. Stillman W., 1353 Highland St., Columbus, Ohio. (30). 1883. **A B D**
Robinson, Miss Winifred J., Instructor in Botany, Vassar College, Poughkeepsie, N. Y., (55). **G**
Rochester, DeLancey, M. D., 469 Franklin St., Buffalo, N. Y. (35). **F**
Rockey, A. E., M. D., 778 Flanders St., Portland, Oregon. (51). **K**
*Rockwood, Charles G., Jr., 34 Bayard Lane, Princeton, N. J. (20). 1874. **A B D E**
*Rockwood, Elbert W., Professor of Chemistry and Toxicology, College of Medicine, State University of Iowa, Iowa City, Iowa. (50). 1906. **C K**
*Roe, Edward Drake, Jr., Professor of Mathematics, Syracuse University, Syracuse, N. Y. (50). 1906. **A**
Roessler, Franz, 39 High St., Perth Amboy, N. J. (39).
*Roever, William Henry, Mass. Inst. Technology, Boston, Mass. (53). 1906. **A**
Rogers, Miss Anne Fuller, 126 Newbury St., Boston, Mass. (52). **F**
Rogers, Edward L., 71 Broadway, New York, N. Y. (50).
Rogers, Howard J., Department of Education, Albany, N. Y. (52).
Rolfs, Peter H., Tropical Laboratory U. S. Department Agriculture, Miami, Fla. (41). 1899. **G**

Rollins, William Herbert, M. D., 250 Marlborough St., Boston, Mass. (50). **B K**

*Rominger, Dr. Carl, Ann Arbor, Mich. (21). 1879. **E**

*Root, Hon. Elihu, Secretary of State, Washington, D. C. (50). 1901. **I**

Rorer, James Birch, Hotel Marseille, Broadway and 103rd St., New York, N. Y. (51). **G**

*Rorer, Jonathan T., Ph. D., Central High School, Philadelphia, Pa. (47). 1906.

*Rosa , Edward Bennett, Bureau of Standards, Washington, D. C. (39). 1892. **A B**

*Rose, Joseph Nelson, U. S. National Museum, Washington, D. C. (52). 1905. **G**

Rose, Lewis H., Associate Prof., Chemistry and Physics, Univ. of Arkansas, Fayetteville, Ark. (52). **B C**

*Rosenau, Milton J., M. D., Director Hygienic Laboratory, U. S. Public Health and Marine Hospital Service, Washington, D. C. (51). 1906. **K**

*Ross, Bennett Battle, Professor of Chemistry, Alabama Polytechnic Institute, Auburn, Ala. (45). 1906. **C**

*Ross, Denman Waldo, Ph. D., 24 Craigie St., Cambridge, Mass. (29). 1906.

*Rotch, A. Lawrence, Director of Blue Hill Meteorological Observatory, Hyde Park, Mass. (39). 1896. **B**

*Rotch, T. M., M. D., 197 Commonwealth Ave., Boston, Mass. (51). 1906. **K**

Roth, Filibert, University of Michigan, Ann Arbor, Mich. (39). **F**

Rothermel, John G., Superintendent, Wagner Free Institute of Science. Philadelphia, Pa. (53).

Rothermel, John J., Teacher of Physics, Eastern High School, Washington, D. C. (51). **B**

Rothschild, Jacob, Hotel Majestic, New York, N. Y. (50).

*Rotzell, W. E., M. D., 200 S. 40th St., Philadelphia, Pa. (45). 1906. **F H**

Rowe, Jesse Perry, Professor of Physics and Geology, University of Montana, Missoula, Montana. (52). **B E**

*Rowlee, W. W., Cornell Univ., Ithaca, N. Y. (41). 1894. **G**

Roy, Arthur J., C. E., Dudley Observatory, Albany, N. Y. (50). **A**

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*Ruddick, William H., M. D., So. Boston, Mass. (51). 1906. **F K**

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Ruete, Otto M., Ph. D., Analytical and Consulting Chemist, 721 Bluff St., Dubuque, Iowa. (51). **C E**

Ruffin, Sterling, M. D., Professor of Theory and Practice of Medicine, George Washington University, Washington, D. C. (52). K

Rugan, H. F., Tulane University, New Orleans, La. (55). D

Ruger, Henry A., Prof. of Psychology, Colorado College, Colorado Springs, Colo. (54). H K

Ruland, Frederick D., M. D., Westport, Conn. (51). B C K

Ruland, M. A., 53 Linden Ave., Flatbush, Brooklyn, N. Y. (43).

Rumbold, Miss Caroline, Konigl. Ludwig-Maximilians Universitat, München, Germany. (53). G

*Running, Theodore R., Ph. D., Dept. of Engineering, Univ. of Michigan, Ann Arbor, Mich. (50). 1906. A

Rup[illegible], August, A. B., College of City of New York, New York, N. Y. (35).

Ruppersburg, Miss Emma A. 842 So. High St., Columbus,O. (48). B

*Rusby, Henry H., M. D., 115 West 68th St., New York, N. Y. (36). 1890. G

Rusk, Glanville Y., M. D., N. Y. Pathological Institute, Wards Island, New York, N. Y. (54). K

*Russell, A. H., Lieut. Col. U. S. A., Ordnance Office, War Dept., Washington, D.C. (38). 1906. D

*Russell, Prof. H. L., University of Wisconsin, Madison, Wis. (41). 1894. G

*Russell, Henry Norris, 79 Alexander St., Princeton, N. J. (54). 1906. A

*Russell, Prof. Israel C., University of Michigan, Ann Arbor, Mich. (25). 1882. E

*Russell, James E., Dean of Teachers' College, West 120th St., New York, N. Y. (50). 1901. H I

Russell, John B., Superintendent of Schools, Wheaton, Ill. (51). C

Russell, Thomas Hubbard, M. D., New Haven Hospital, 137 Elm St., New Haven, Conn. (54). K

Ruthven, Alex. G., Univ. Museum, Ann Arbor, Mich. (54). F

*Rutter, Frank Roy, Ph. D., U. S. Dept. Agriculture, Washington, D. C. (47). 1900. I

*Ryan, Harris J., Cornell University, Ithaca, N. Y. (38). 1890. B

*Rydberg, Dr. Per Axel, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (49). 1901. G

*Sabine, Wallace Clement, 40 Shepard St., Cambridge, Mass. (47). 1900. B

*Sachs, B., M. D., 21 E. 65th St., New York, N. Y. (49). 1903. K

Sackett, Miss Eliza D., Cranford, N. J. (35).

Sackett, Robert L., C. E., Professor of Civil Engineering, Earlham College, Richmond, Ind. (50). A

Sackett, Walter George, Agricultural College, Mich. (52). **F G**

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*Safford, Frederick Hollister, Ph. D., Univ. of Pennsylvania, Philadelphia, Pa. (54). 1906. **A**

Safford, William Edwin, Dept. Agriculture, Washington, D. C. (55). **G**

*Sage, John Hall, Portland, Conn. (23). 1906. **F**

*St. John, Prof. Charles E., 125 Elm St., Oberlin, Ohio. (46). 1900. **B**

*Sajous, Charles Euchariste de Médicis, No. 2043 Walnut St., Philadelphia, Pa. (54). 1906. **K**

Sale, Rev. Samuel, 4010 West Bell St., St. Louis, Mo. (53). **I**

Salathé, Frederick, Ph. D. care of Joseph H. Lobell, Casper, Wyo. (51).

*Salisbury, Prof. R. D., Chicago University, Chicago, Ill. (37). 1890. **B E**

*Salmon, Dr. Daniel E., Washington, D. C., (31). 1885. **F**

*Sampson, Alden, Haverford, Pa. (54). 1906. **F**

Sander, Dr. Enno, St. Louis, Mo. (27). **C**

Sanders, James G., U. S. Dept. Agriculture, Washington, D. C. (54) **F**

*Sanderson, E. Dwight, Agr. Exp. Sta., Durham, N. H. (50). 1903. **F**

Sando, Will J., care Allis-Chalmers Co., Milwaukee, Wis. (51). **E**

Sandsten, E. P., Univ. of Wisconsin, Madison, Wis. (54).

Sanes, K. I., M. D., 1636 5th Ave., Pittsburg, Pa. (51). **K**

*Sanford, E. C., Professor of Psychology, Clark University, Worcester, Mass. (49). 1902. **H I K**

*Sanford, Fernando, Professor of Physics, Stanford University, Cal. (50). 1901. **B**

*Sardeson, Frederick William, Ph. D., Instructor in Geology, University of Minnesota, Minneapolis, Minn. (50). 1906. **E**

Sargent, Ara Nathaniel, M. D., 116 Federal St., Salem, Mass. (51). **K**

*Sargent, Dudley Allen, M. D., Director of the Hemenway Gymnasium, Harvard University, Cambridge, Mass. (47). 1899. **H**

Sargent, Frederick Le Roy, 27 Everett St., Cambridge, Mass. (54). **G**

Sargent, Winthrop, Haverford, Pa. (54). **D**

Sarle, Clifton J., Yale University Museum, New Haven, Conn. (55). **E**

Satterlee, F. LeRoy, M. D., 8 W. 18th St., New York, N. Y. (50). **K**

*Saunders, A. P., Ph. D., Hamilton College, Clinton, N. Y. (48). 1900. **C**

*Saunders, Charles E., Ph. D., Central Experimental Farm, Ottawa, Canada. (41). 1895. G

Saunders, Edward W., M. D., 3003 Lafayette Ave., St. Louis, Mo. (51). K

*Saunders, F. A., Ph. D., Instructor in Physics, Syracuse University, Syracuse, N. Y. (48). 1906. B

Saunders, James, M. D., Lock Box 147, Orange, Texas. (52). K

*Saunders, William, LL.D., F. R. S. C., F. L. S., Canadian Experimental Farms, Ottawa, Canada. (17). 1874. F

Saunders, Wm. H., 1407 F St., N.W., Washington, D. C. (52). I

Savage, Thomas E., Assistant State Geologist, Iowa Geological Survey, Des Moines, Iowa. (52). E F G

*Savage, Watson L., M. D., Mamaroneck, N. Y. (51). 1902. K

*Saville, Marshall H., Amer. Mus. Nat. History, Central Park New York, N. Y. (39). 1892. H

Sawyer, Edward, Civil and Mechanical Engineer, Newton, Mass. (51). D

Sayles, Robert Wilcox, 253 Broadway, Norwich, Conn. (55). E

*Sayre, Herbert Armistead, Prof. Physics and Astronomy, Univ. of Alabama, University, Ala. (54). 1906. A B

*Sayre, Robert H., South Bethlehem, Pa. (28). 1899. D

Scaife, William Lucien, 28th St., Pittsburg, Pa. (51). B D

*SCHAEBERLE, J. M., 502 Second St., Ann Arbor, Mich. (34). 1886. A

Schaeffer, Henri N. F., care of Montreal Cotton Co., Valleyfield, Canada. (46). C

SCHAFFER, MRS. MARY TOWNSEND SHARPLESS, 1309 Arch St., Philadelphia, Pa. (38). E F

*Schaffner, John H., Ohio State University, Columbus, Ohio. (48). 1899. G

Schaller, Waldemar T., U. S. Geological Survey, Washington, D. C. (53). E

Scharar, Christian H., 2073 N. Main Ave., Scranton, Pa. (33). A D E H

Schenck, Charles C., Ph. D., McGill University, Montreal, Canada. (51). B

Scherf, C. Harry, Kalispell, Montana. (53). F

SCHERMERHORN, F. AUG., 101 University Place, New York, N. Y. (36).

SCHERMERHORN, WM. C., 49 West 23d St., New York, N. Y. (36).

Schernikow, Ernest, P. O. Box 1191, New York, N. Y. (49).

Schiaffino, Mariano L., Chief Electrical Engineer, "Campania de Luz de Guadalajara," Belen 2, Apartado 260, Guadalajara, Mexico. (50). D

Schiedt, Richard Conrad, Professor of Biology, Franklin and Marshall College, Lancaster, Pa. (50). **F**

Schieffelin, Eugene, 865 Madison Ave., New York, N. Y. (50).

Schiertz, Ferdinand Alfred, Apartado 19, Tlalpujahua, Est. de Michoacan, Mexico. (50). **D E**

*Schlesinger, Frank, Yerkes' Observatory, Williams Bay, Wis. (51). 1902. **A**

Schlichting, Emil, Analytical Chemist, 38 Cranberry St., Brooklyn, N. Y. (50). **C**

*Schlotterbeck, Julius O., 1319 Israel Hall Ave., Ann Arbor, Mich. (46). 1899. **G**

*Schmeckebier, Lawrence Frederick, Ph. D., U. S. Geol. Survey, Washington, D. C. (50). 1902. **E I**

Schmid, Dr. H. Ernest, White Plains, N. Y. (25).

Schmitt, A. Emil, M. D., 103 East 60th St., New York, N. Y. (50). **K**

Schmitt, Ewald, C. E., 211 Florida Ave., N. W., Washington, D. C. (51).

*Schmucker, Samuel Christian, Ph. D., Professor of Biology, Normal School, West Chester, Pa. (53). 1906. **F G**

*Schneider, Albert, Cal. College Pharmacy, Parnassus Ave., San Francisco, Cal. (54). 1906. **C**

Schneider, Edward Christian, Ph, D. Professor of Biology, Colorado College, Colorado Springs, Colo. (55). **F G**

*Schober, Wm. Bush, Lehigh University, South Bethlehem, Pa. (52). 1905. **C**

Schobinger, John J., Morgan Park, Ill. (34). **B**

*Schöney, L., M. D., St. James Court, 143d St. and 7th Ave., New York, N. Y. (29). 1900. **F**

Schoonhoven, John J., 34 Second Place, Brooklyn, N. Y. (52). **G**

*Schuchert, Charles, Yale Museum, New Haven, Conn. (52). 1905. **E F**

Schuette, J. H., Green Bay, Wis. (34). **B E F**

Schuh, Richard Edwin, Ph. D. Professor of Biology, State Normal School, California, Pa. (54).

Schultz, Carl H., 430–444 First Ave., bet. 25th and 26th Sts. New York, N. Y. (29).

Schultz, Louis G., Mount Weather Observatory, Bluemont, Va. (52). **B**

*Schultze, Arthur, 4 West 91st St., New York, N. Y. (54). 1906. **A**

*Schurman, Jacob Gould, LL.D., President Cornell University; Ithaca, N. Y. (49). 1901.

Schuyler, Philip, Irvington-on-Hudson, N. Y. (49).

Schwab, Dr. Sidney I., 4393 Westminster Place, St. Louis, Mo. (52). **K**

*Schwarz, E. A., U. S. Department of Agriculture, Washington, D. C. (29). 1895. F

*Schweitzer, Paul, Professor of Chemistry, State Univ. of Missouri, Columbia, Mo. (24). 1877. B C

Scofield, Carl S., Department of Agriculture, Washington, D. C. (52). G

Scott, Prof. Arthur William, St. David's College, Lampeter, S. Wales, England. (46). A B

*Scott, Charles F., Westinghouse Electric and Mfg. Co., Pittsburg, Pa. (48). 1900. B

*Scott, W. M., U. S. Dept. Agriculture, Washington, D. C. (50). F

Scovel, Edward C., Rosebud, S. Dak. (52).

*Scovell, M. A., Director and Chemist, Agricultural Experiment Station, Lexington, Ky. (35). 1887. C

Scripture, Arthur M., Principal of High School, New Hartford, N. Y. (51). D

*Scripture, E. W., Phonetic Laboratory, Rigistr, 47, Zurich, Switzerland. (46). 1901. H

*Scudder, Samuel H., Cambridge, Mass. (13). 1874. F

*Scull, Miss Sarah A., Smethport, Pa. (40). 1895. H

Seal, Alfred Newlin, Ph. D., Professor of Chemistry, Girard College, Philadelphia, Pa. (50). B C

*Seaman, Arthur Edmund, Professor of Geology and Mineralogy, Michigan College of Mines, Houghton, Mich. (53). 1906. E

*Seaman, W. H., Chemist, 1424 11th St. N.W., Washington, D. C. (23). 1874. C F

Searle, Frederick Edwards, Detroit University School, Detroit. Mich. (52). B

*Searle, Rev. George M., Paulist Fathers, 415 West 59th St., New York, N Y. (39). 1891. A

Sears, Frederick Edmund, St. Paul's School, Concord, N. H. (47). C E

Sears, Henry Francis, M. D., 8 Beacon St., Boston, Mass. (50).

*Seashore, Carl E., Univ. of Iowa, Iowa City, Iowa. (49). 1902. H

Seawell, Benjamin Lee, Teacher of Biology, State Normal School, Warrensburg, Mo. (50). F

Secor, William Lee, Academia, Ohio. (52). C

Sedgwick, Howard M., M. D., 512 Woolner Bldg., Peoria, Illinois. (52). B C K

*Sedgwick, Prof. William Thompson, Massachusetts Institute of Technology, Boston, Mass. (47). 1898. F G K

See, James W., M. E., Opera House, Hamilton, Ohio. (51). D

*See, Prof. T. J. J., Observatory, Mare Island, Cal. (48). 1901. A

*Seelig, M. G., M. D., 3908 Olive St., St. Louis, Mo. (54). 1906. K

*Segerblom, Wilhelm, Professor of Chemistry, Phillips Exeter Academy, Exeter, N. H. (53). 1906. G

*Selby, Augustine Dawson, Agric. Exper. Station, Wooster, Ohio. (44). 1900. G

Seligman, Isaac N., Mills Building, New York, N. Y. (49).

*Sellards, Elias Howard, Prof. Zoology & Geology, Univ. of Florida, Lake City, Fla. (54). 1906. E F

*Sellers, James Freeman, Prof. of Chemistry, Mercer University, Macon, Ga. (50). 1906. C

*Serrell, Gen. Edward Wellman, C. E., Forest Ave., West New Brighton, N. Y. (50). 1906. B C D

*Serviss, Garrett P., 8 Middagh St., Brooklyn, N. Y. (52). 1906.

Sessinghaus, Gustavus, E. M., Farmington, Mo. (50). E

Sever, George F., Electrical Engineer, Broadway and 117th St., New York, N. Y. (49). B

Seymour, George Steele, 17 Battery Place, New York, N. Y. (51). B C

*Seymour, Paul Henry, 245 East 61st St., Chicago, Ill. (44). 1896. C

Shafer, John A., Custodian of the Museums, N. Y. Botanical Garden, Bronx Park, New York, N. Y. (51). G

Shaffner, Samuel C., Supt. Electric Lighting Co., Mobile, Ala. (50). C D

Shamel, Archibald D., U. S. Dept. of Agriculture, Washington, D. C. (52). G

*Shantz, Homer Le Roy, Ph. D., Instructor in Botany, University of Missouri, Columbia, Mo. (50). 1903. F G

Sharpe, Benjamin F, Greenwich, N. Y. (50). B.

Sharp, Charles Cutler, C. E., E. M., Gauley Bridge, W. Va. (50). D E

*Sharp, Dr. Clayton H., Electrical Testing Laboratory, 80th St. and East End Ave., New York, N. Y. (45). 1897. B

Sharpe, Richard W., Township High School, Wilmette, Ill. (51). F

Sharples, Philip Price, A. B., 22 Concord Ave., Cambridge, Mass. (47). C

*Sharples, Stephen P., 26 Broad St., Boston, Mass. (29). 1884. C

*Shattuck, Frederick C., M. D., Professor Clinical Medicine, Harvard Medical College, Boston, Mass. (50). 1901. F K

Shattuck, George Brune, M. D., 183 Beacon St., Boston, Mass. (54). K

*Shattuck, George Burbank, Johns Hopkins University, Baltimore, Md. (47). 1899. E K

Shattuck, John D., 517 Market St., Chester, Pa. (54). D

*Shattuck, Samuel Walker, Professor of Mathematics, University of Illinois, Urbana, Ill. (50). 1902. A

*Shaw, Dr. Charles Hugh, Ursinus College, Collegeville, Pa. (52). 1906. G

Shaw, Edwin C., M. E., 104 Park St., Akron, Ohio. (50). **D**

Shaw, Henry Clay, C. E., Glenshaw, Pa. (51). **D**

Shaw, Henry Lyman, M. D., 19 Commonwealth Ave., Boston, Mass. (51). **K**

*Shaw, Walter Robert, Ph. D., Campbell, Cal. (47). 1902. **F G**

Shaw, Wilson A., Cashier, Merchants and Manuf. National Bank, Norwood Ave., cor. Forbes Ave., Pittsburg, Pa. (50). **I**

*Shea, Daniel William, Prof. of Physics, Catholic University of America, Washington, D. C. (54). 1906. **B**

SHEAFER, A. W., Pottsville, Pa. (28).

*Shear, Cornelius L., U. S. Dept. Agriculture, Washington, D. C. (49). 1901. **G**

*Shearer, John Sanford, Instructor in Physics, Cornell University, Ithaca, N. Y. (52). 1906. **B**

*Shedd, John C., Prof. of Physics, Colorado College, Colorado Springs, Colo. (50). 1906. **A B**

*Shedd, Solon, Professor of Geology and Mining, Agricultural College, Pullman, Wash. (50). 1906. **E**

Sheffield, George St. John, Twin Elms Farm, Attleborough, Mass. (50).

Sheldon, Edmund P., Sec'y. Oregon Lumber Mfgn. Assn., 265 Washington St., Portland, Oregon. (54). **G**

*Sheldon, John Lewis, Ph. D., Bacteriologist, W. Va. Agr. Exp. Station, Morgantown, W. Va. (50). 1903. **G**

Sheldon, Mrs. J. M. Arms, 18 W. Cedar St., Boston, Mass. (44). **F**

*Sheldon, Samuel, Ph. D., Polytechnic Institute, Brooklyn, N. Y. (42). 1894. **B**

*Sheldon, Wilmon H., Ph. D., Tutor in Philosophy, Columbia University New York, N. Y. (54). 1906. **H I**

Sheldon, W. L., 4533 Westminster Place, St. Louis, Mo. (54).

*Shelton, Prof. Edward M., 2904 Franklin Ave., Seattle, Wash. (32). 1892. **F**

Sheppard, John Frederick, 513 Thompson St., Ann Arbor, Mich. (54). **H K**

SHEPHERD, MISS ELIZABETH, 253 W. 128th St., New York, N. Y. (39).

Shepherd, Frank I., Whittier, Cal. (48). **C**

Sheppard, Hon. Morris, Member of Congress, Texarkana, Texas. (51).

Shepperd, J. H., Dean and Vice Director, North Dakota Agric. College, Agricultural College, North Dakota. (54).

*Sherman, Henry Clapp, Instructor in Analytical Chemistry, Columbia University, New York, N. Y. (51). 1906. **C**

Sherman, Lewis, M. D., 448 Jackson St., Milwaukee, Wis. (50). **F K**

Sherwood-Dunn, B., M. D., Easton, Pa. (51). **K**

Shidy, Leland P., Coast and Geodetic Survey Office, Washington, D. C. (52). G

*Shimek, Bohumil, Professor of Botany, State University of Iowa, Iowa City, Iowa. (52). 1903. E G

Shimer, Hervey Woodburn, Instructor in Geology, Massachusetts Institute of Technology, Boston, Mass. (53). E

*Shimer, Porter W., E. M., Ph. D., Easton, Pa. (38). 1889. C

Shinn, Charles Howard, Head Forest Ranger, Northfork, Cal. (50). F G

Shore, Albert Ferdinand, 209 Nassau Ave., Brooklyn, N. Y. (54). D

Short, R. L., Care D. C. Health & Co., 378-388 Wabash Ave., Chicago, Ill. (55).

Shott, John A., Dept. of Physics, Westminster College, New Wilmington, Pa. (53). B

Shropshire, Walter, M. D., Yoakum, Texas. (50). F K

SHRYOCK, WM. KNIGHT, 21 North 7th St., Philadelphia, Pa. (54).

*Shull, George Harrison, Station for Experimental Evolution, Cold Spring Harbor, L. I., N. Y. (53). 1905. G

Shultz, Charles S., Hoboken, N. J. (31). F

Shurly, E. L., M. D., 32 Adams Ave., West Detroit, Mich. (51). K

Shurtleff, Eugene, M. D., 73 Hancock St., Dorchester Dist., Boston, Mass. (52). K

*Shute, D. K., M. D., 1719 De Sales St., N.W., Washington, D. C. (50). 1906. F I K

*Shutt, Frank T., F. E. C., F. C. S., Dominion Experimental Farms, Ottawa, Canada. (47). 1898. C

*Sias, Solomon, M. D., Schoharie, N. Y. (10). 1874. K

Sickels, Ivin, M. D., 17 Lexington Ave., New York, N. Y. (50). F K

Siedenburg, Frederic, Professor of Physics, St. Louis University Grand Ave. and Pine St., St. Louis, Mo. (53). B

Siemon, Rudolf, 22 East Jefferson St., Fort Wayne, Ind. (40). A F

*Sigerfoos, Chas. Peter, Prof. Zoology, University of Minnesota, Minneapolis, Minn. (54). 1906. F

*Sigsbee, Charles D., Rear Admiral, U. S. N., Navy Department, Washington, D. C. (28). 1882. D E

*Silloway, Perley Milton, Principal of High School, Lewiston, Montana. (51). 1906. F

Silvester, Charles Frederick, Curator Morphological Museum and Assistant in Anatomy, Princeton University, 10 Nassau Hall, Princeton, N. J. (54). F

Silvester, Richard W., President Maryland Agricultural College, College Park, Md. (50). G

Simkhovitch, Dr. V. G., Columbia University, New York, N. Y. (54). I

*Simon, Dr. Wm., 1348 Block St., Baltimore, Md. (29). 1895. C

*Simonds, Frederic W., Professor of Geology, University of Texas, Austin, Texas. (25). 1888. **E F**

Simpson, Charles Baird, Department of Agriculture, Pretoria, Transvaal, S. Africa. (52). **F G**

Simpson, Jesse Pickrell, M. D., Palmer, Ill. (51). **K**

Simpson, John Crayke, M. D., 1738 15th St., N. W., Washington, D. C. (51). **K**

Simpson, Quintus Irvin, Palmer, Ill. (54). **F H**

Sinclair, Alexander Grant, M. D., Equitable Bldg., Memphis, Tenn. (52). **K**

Sinclair, Cephas Hempstone, Coast and Geodetic Survey, Washington, D. C. **A**

Singer, George Park, Central State Normal School, Lock Haven, Pa., (50). **B**

Six, William Lewis, Philippi, W. Va. (53). **D**

Skiff, F. J. V., Director, Field Columbian Museum, Chicago, Ill. (43).

*Skinner, Aaron Nichols, U. S. Naval Observatory, Washington, D. C. (40). 1893. **A**

*Skinner, Charles Edward, Engineering Dept. Westinghouse Electrical & Manfg. Co., East Pittsburgh, Pa. (54). **D**

*Skinner, Clarence A., Ph. D., University of Nebraska, Lincoln, Neb. (48). 1903. **B**

*Skinner, Henry, M. D., 716 N. 20th St., Philadelphia, Pa. (47). 1902. **F K**

Slade, Denison Rogers, Centre Harbor, N. H. (R. F. D.) (55). **E**

Slade, Elisha, Somerset, Mass. (29). **F**

Slagle, Robert Lincoln, Ph. D., Brookings, S. D. (50). **C E**

*Slichter, Charles S., Professor of Applied Mathematics, University of Wisconsin, Madison, Wis. (51). 1902. **A**

*Slingerland, Mark Vernon, Assistant Professor of Economic Entomology, Cornell University, Ithaca, N. Y. (50). 1901. **F**

Slipher, V. M., Lowell Observatory, Flagstaff, Arizona. (52). **A**

Slocum, Chas. E., M. D., Defiance, Ohio. (34). **F G H**

*Slocum, Frederick, Ph. D., Ladd Observatory, Providence, R. I. (47). 1906.

Slonaker, J. Rollin, Stanford University, Cal. (49). **F**

*Slosson, Edwin E., Associate Editor, The Independent, 130 Fulton St., New York, N. Y. (50). 1901. **C**

*Small, John Kunkel, N. Y. Botanical Garden, Bedford Park, New York, N. Y. (44). 1902. **G**

Smallwood, Miss Mabel Elizabeth, 6112 Ingleside Ave., Chicago, Ill. (52). **F**

*Smallwood, William Martin, Syracuse University, Syracuse, N. Y. (50). 1903. **E F**

Smillie, Thomas W., U. S. National Museum, Washington, D. C. (40). F

*Smith, Prof. Albert W., Case School of Applied Science, Cleveland, Ohio. (47). 1900. C

*Smith, Alexander, Ph. D., University of Chicago, Chicago, Ill. (40). 1892. C

Smith, Alice Maude, M. D., 327 North G St., Tacoma, Wash. (53). K

*Smith, Allen J., M. D., University of Pennsylvania, Philadelphia, Pa. (47). 1905. H

*Smith, Andrew H., M. D., 18 East 46th St., New York, N. Y. (54). 1906. K

Smith, Mrs. Annie Morrill, 78 Orange St., Brooklyn, N. Y. (49). G

*Smith, Arthur Whitmore, Ph. D., University of Michigan, Ann Arbor, Mich. (44). 1906. B

Smith, Burnett, Skaneateles, N. Y. (54). E

*Smith, Prof. Charles J., 35 Adelbert St., Cleveland, Ohio. (32). 1885. A B

*Smith, Prof. Edgar F., University of Pennsylvania, Philadelphia, Pa. (33). 1891. C

*Smith, Erastus G., Ph. D., Director Beloit Sanitary Laboratory, Beloit, Wis. (34). 1887. C

*Smith, Ernest Ellsworth, 26 East 29th St., New York, N. Y. (43). 1898. F K

*Smith, Erwin F., U. S. Dept. Agriculture, Washington, D. C. (34). 1890. G

Smith, Eugene, C. E., 317 Washington St., Hoboken, N. J. (50). D

*Smith, Prof. Eugene Allen, State Geologist, University, Ala. (20). 1877. C E

*Smith, Francis Henry, University Station, Charlottesville, Va. (54). 1906.

*Smith, Frank, University of Illinois, Urbana. Ill. (49). 1900. F

Smith, Franklin Hans, Denton, Texas. (55). A

Smith, Fred. W., Dept. Science, Northern Normal and Industrial School, Aberdeen, S. D. (54). F

*Smith, George Otis, U. S. Geological Survey, Washington, D. C. (52). 1906. E

*Smith, Harlan I., Amer. Mus. Nat. History, Central Park, New York, N. Y. (41). 1896. H

*Smith, Harold B., Professor of Electrical Engineering, Polytechnic Institute, Worcester, Mass. (43). 1898. D

Smith, Harvey F., Attorney at Law, Clarksburg, W. Va. (50). I

Smith, Herbert Stearns Squier, Professor of Applied Mechanics, Princeton University, Princeton, N. J. (29). **D**

*Smith, Hugh M., Bureau of Fisheries, U. S. Dept. Commerce and Labor, Washington, D. C. (52). 1906. **F**

Smith, Miss J. Angelina, Hopedale, Mass. (45). **E**

Smith, J. C., 131 Carondelet St., New Orleans, La. (48).

Smith, Prof. J. F., President Commercial College, Dallas, Texas. (52). **I**

Smith, James Hervey, 217 North Central Ave., Chicago, Ill. (40).

*Smith, Jared G., Hawaiian Experiment Station, Honolulu, T. H. (47). 1901. **G**

SMITH, MISS JENNIE M., 40 Library Place, Allegheny City, Pa. (50). **A F**

*Smith, John B., Ph. D., Rutgers College, New Brunswick, N. J. (32). 1884. **F**

Smith, Joseph R., M. D., LL. D., Brig. Gen'l. and Assistant Surgeon General, U. S. A., 2135 Spruce St., Philadelphia, Pa. (43).

Smith, Lee H., M. D., President Buffalo Society of Natural Science, 663 Main St., Buffalo, N. Y. (51). **H**

Smith, L. Brewster, 6024 Hurst St. ,New Orleans, La. (55). **A B**

SMITH, MISS MATILDA H., 40 Library Place, Alleghany City, Pa. (50). **A**

Smith, Matthew Mann, M. D., Austin, Texas. (50). **F K**

Smith, Middleton, 1616 19th St., N.W., Washington, D. C. (52).

Smith, Philip Sidney, U. S. Geol. Survey, Washington, D. C. (47). **E**

*SMITH, Q. CINCINNATUS, M. D., 617 Colorado St., Austin, Texas, (26). 1881. **K**

Smith, R. I., State Entomologist, Atlanta, Ga. (54). **F**

Smith, S. MacCuen, M. D., 1700 Walnut St., Philadelphia, Pa. (54). **K**

Smith, Thomas A., Professor of Mathematics and Physics, Beloit College, Beloit, Wis. (50). **A B**

Smith, T. Guilford, Civil Engineer, Regent University, State of New York, Buffalo, N. Y. (50). **D**

Smith, W. Hinckle, 2025 Locust St., Philadelphia, Pa. (54).

*Smith, Warren Rufus, Instructor in Chemistry, Lewis Institute. Chicago, Ill. (52). 1906. **C**

*Smith, William Benjamin, Professor of Mathematics, Tulane University, New Orleans, La. (50). 1901. **A**

Smith, Wm. Lincoln, Consulting Electrical and Illuminating Engineer, Concord, Mass. (47). **D**

*Smith. W. S. Tangier, Ph. D., Box 30, Los Gatos, Cal. (50). 1906. **E**

Smith, William T., M. D., Prof. of Physiology and Dean of Dartmouth Medical School, Hanover, N. H. (51). **K**

*Smock, Prof. John Conover, Trenton, N. J. (23). 1879. **E**

Smock, Ledru Pierson, M. D., 3330 Chestnut St, Philadelphia, Pa. (54).

*Smyth, C. H., Jr., Princeton University, Princeton, N. J. (38). 1894. **E**

*Sneath, E. Hershey, Professor of Philosophy, Yale University, New Haven, Conn. (51). 1902. **H**

Snedaker, James Angus, Mining Engineer, 850 Equitable Bldg., Denver, Colo. (50). **D**

Sneve, Haldor, M. D., Lowry Arcade, St. Paul, Minn. (51). **K**

*Snow, Benjamin W., 518 Wisconsin Ave., Madison, Wis. (35). 1889. **B**

Snow, Charles Carleton, 1411 20th St., N.W., Washington, D. C. (52).

*Snow, F. H., LL. D., Professor of Natural History, University of Kansas, Lawrence, Kan. (29). 1881. **E F**

Snow, Walter B., 29 Russell Ave., Watertown, Mass. (53). **D**

Snyder, Fred. D., M. D., 10 Center St., Ashtabula, Ohio. (51). **E F H**

*Snyder, Prof. Harry, Agricultural College, University of Minnesota, Saint Anthony Park, Minn. (44). 1897. **C**

*Snyder, Prof. Monroe B., Philadelphia Astronomical Observatory, Philadelphia, Pa. (24). 1882. **A B**

Snyder, Zachariah Xenophon, President State Normal School, Greeley, Colo. (50). **F**

*Sollmann, Torald, M. D., Professor of Pharmacology and Materia Medica, Medical College, Western University, Cleveland, Ohio. (52). 1906. K

Solyom, Herbert Louis, Mt. Weather, Bluemont, Va. (55). **A B**

Soper, George A., Ph. D., 29 Broadway, New York, N. Y. (46). **C**

*Soule, R. H., 1571 Beacon St., Brookline, Mass. (33). 1886. **D**

*Soule, William, Ph. D., Mount Union Coll., Alliance, Ohio. (33). 1899. **B C E**

Southall, James P. C., Professor of Physics, Alabama Polytechnic Institute, Auburn, Ala. (51). **B**

Souvielle, Mathieu, M. D., Box 355, Jacksonville, Fla. (36). **B E F**

Souvielle, Mrs. Mathieu, Box 355, Jacksonville, Fla. (24). **A B F**

*Spalding, Frederick P., Professor of Civil Engineering, Univ. of Missouri, Columbia, Mo. (46). 1899. **D**

*Spalding, Volney, M., Ph. D., Tucson, Arizona. (51). 1902. **G**

Spangler, Harry Allen, M. D., Carlisle, Pa. (51). **K**

*Spaulding, Edward G., Ph. D., College of the City of New York, New York, N. Y. (50). 1905. **I**

Spaulding, Perley, Missouri Botanical Garden, St. Louis, Mo. (52). **G**

Spayd, Henry Howard, Principal of Schools, Minersville, Pa. (52). **B E K**

Spear, Gen. Ellis, 1601 Laurel Ave., Mt. Pleasant, Washington, D. C. (52). **D**

*Spencer, Arthur Coe, U. S. Geological Survey, Washington, D. C. (52). 1905. **E**

*Spencer, Prof. J. W., 1718 21st St. N.W., Washington, D. C. (28). 1882. **E**

*Spenzer, John G., M. D., 716 Rose Bldg., Cleveland, Ohio. (37). 1895. **C**

Sperry, Elmer A., Electrical Engineer, 366–388 Massachusetts Ave., Buffalo, N. Y. (51). **D**

*Speyers, Clarence Livingston, Associate Professor Chemistry, Rutgers College, New Brunswick, N. J. (50). 1901. **C**

Spiegelhalter, Dr. Joseph, 2166 Lafayette Ave., St. Louis, Mo. (47). **E**

Spiegle, Grace Edgar, M. D., 2115 North 12th St., Philadelphia, Pa. (54). **K**

*Spillman, Wm. Jasper, U. S. Dept. of Agr., Washington, D. C. (52). 1905. **G**

*Spinney, Prof. L. B., Iowa State College, Ames, Iowa. (42). 1897. **B**

*Spitzka, Edward Anthony, M. D., 66 East 73d St., New York, N. Y. (54). 1906. **H**

Spofford, Paul N., P. O. Box 1667, New York, N. Y. (36).

Spohn, Arthur Edward, M. D., Corpus Christi, Texas. (50). **F K**

Sprague, C. C., 1900 Locust St., St. Louis, Mo. (50).

Sprague, C. H., Malden, Mass. (29).

*Sprague, Robert James, Knox College, Galesburg, Ill. (53). 1906. **I**

Sprigg, Wm. Mercer, M. D., 1015 16th St., N.W., Washington, D. C. (52). **K**

*Springer, Dr. Alfred, 312 E. 2d St., Cincinnati, Ohio. (24). 1880. **C**

*Springsteen, Harry W., Bryn Mawr, Pa. (49). 1906. **A B**

Squibb, Charles F., Bernardsville, N. J. (43).

Squibb, Edward Hamilton, M. D., 148 Columbia Heights, Brooklyn, N. Y. (41). **F K**

*Squier, Major George Owen, U. S. A., Signal School, Ft. Leavenworth, Kans. (54). 1906. **B**

Stackpole, Miss Caroline E., Teacher of Physics and Chemistry, State Normal School, Plattsburgh, N. Y. (53). **B C F G**

Stahley, George D., M. D., Gettsyburg, Pa. (47). **F G**

Stair, Leslie Dalrymple, 92 Wadena St., Cleveland, Ohio. (52). **G**

Stanislas, Sister M., 220 Plainfield Ave., Joliet, Ill. (53). **I**

Stanley, William, Great Barrington, Mass. (50).

*Stanley-Brown, Joseph, Cold Spring Harbor, L. I., N. Y. (52). 1906.

STANTON, FRANK MCMILLAN, E. M., Agent of Atlantic, Baltic and Central Mining Co's. Atlantic Mine, Mich. (51). **D E**

Stanton, John R., 15 William St., New York, N. Y. (49).

Stanton, Robert Brewster, Civil and Mining Engineer, 66 Broadway, New York, N. Y. (51). **D**

*Stanton, Timothy W., U. S. Geological Survey, Washington, D. C. (50). 1902. **E**

*Starr, Frederick, Ph. D., University of Chicago, Chicago, Ill. (36) 1892. **E H**

*Starr, M. Allen, M. D., 5 West 54th St., New York, N. Y. (50). 1901. **K**

Starrett, M. G., 349 W. 85th St., New York, N. Y. (49).

Stauffer, Rev. Thomas F., 200 11th St., Sioux City, Iowa. (51). **I**

Stearns, Guy Beckley, M. D., 119 W. 82d St., New York, N. Y. (54). **I K**

*Stearns, H. D., Associate Professor of Physics, Stanford University, Cal. (53). 1906. **B**

*Stearns, Robert E. C., Ph. D., 1025 East Eighteenth St., Los Angeles, Cal. (18). 1874. **F**

Stearns, Theron C., M. D., Consulting Chemist, 44 Montgomery St., Jersey City, N. J. (49).

Stearns, Thomas B., Mining Engineer, 1720 California St., Denver, Colo. (50). **D E**

Stebbins, Miss Fannie A., 480 Union St., Springfield, Mass. (44). **F G**

Steer, Justin, M. D., Medical Department, Washington University, St. Louis, Mo. (50). **F K**

*Steiger, George, Chemical Laboratory, U. S. Geol. Survey, Washington, D. C. (40). 1901. **B C E**

Stein, Dr. Simon G., Muscatine, Iowa. (43).

Steinbach, Lewis W., M. D., 1309 N. Broad St., Philadelphia, Pa. (51). **K**

Steiner, Roland, Ph. D., Grovetown, Ga. (48). **H**

*Steinmetz, Charles Proteus, General Electric Co., Schenectady, N. Y. (40). 1895. **B**

*Stejneger, Leonhard, Curator of Dept. of Reptiles, U. S. National Museum, Washington, D. C. (40). 1892. **F**

Stellwagen, Thos. C., M. D., Prof. Physiology, Philadelphia Dental College, 1328 Chestnut St., Philadelphia, Pa. (51). **K**

Stephens, Henry Matthew, Professor of Biology, Dickinson College, Carlisle, Pa. (50). **F G**

*STEPHENS, W. HUDSON, Lowville, N. Y. (18). 1874. **E H**

Stern, Philip Kossuth, Consulting Mechanical and Electrical Engineer, 130 Fulton St., New York, N. Y. (50). **B D**

Sternberg, Charles Hazelius, Lawrence, Kansas. (50). **E F**

*Sternberg, Gen. George M., M. D., LL. D., U. S. A., 2144 California Ave., N. W., Washington, D. C. (24). 1880. **F**

Sterne, Albert E., M. D., "Norways," Indianapolis, Ind. (51). **K**

Stetson, George R., 1441 Mass. Ave., N. W., Washington, D. C. (49). **H I**

Stevens, Cyrus Lee, M. D., Secy. of the Medical Society of the State of Pa., Athens, Pa. (51). **K**

Stevens, Edward Lawrence, Associate City Superintendent of Schools, 59th St. and Park Ave., New York, N. Y. (52).

*Stevens, Frank L., Ph. D., Prof. of Biology, College of Agric. and Mech. Arts, West Raleigh, N. C. (44). 1899. **G**

Stevens, Frederick W., Department of Physics, Lake Forest University, Lake Forest, Ill. (50). **B**

Stevens, George T., M. D., 22 East 46th St., New York, N. Y. (28). **B F**

Stevens, James Franklin, M. D., 1136 O St., Lincoln, Neb. (50). **F H K**

*Stevens, James S., The University of Maine, Orono, Me. (48) 1900. **B**

Stevens, Nettie Maria, Instructor Experimental Morphology, Bryn Mawr College, Bryn Mawr, Pa. (54). **F G K**

Stevens, Miss Romiett, 520 Clinton St., Hudson, N. Y. (54). **H**

*Stevens, Prof. W. LeConte, Washington and Lee University, Lexington, Va. (29). 1882. **B**

Stevenson, Francis L., Electrical Engineer, Deering Division, International Harvester Co., 79 Lincoln Ave., Chicago, Ill. (47). **D**

*Stevenson, Prof. John J., University Heights, New York, N. Y. (36). 1888. **E**

*Stevenson, Mrs. Matilda Coxe, Bureau of American Ethnology, Washington, D. C. (41). 1893. **H**

Stevenson, Wm. H., Professor of Soils, Iowa State College, Ames, Iowa. (55). **C**

Stewart, Alonzo Hamilton, M. D., Asst. Bacteriologist, Bureau of Health, City Hall, Philadelphia, Pa. (54). **K**

*Stewart, Colin Campbell, Associate Prof. of Physiology, Dartmouth Medical College, Hanover, N. H. (54). 1906. **K**

Stewart, Douglas, Assistant to Director Carnegie Museum, Pittsburg, Pa. (50). **E**

Stewart, Francis Laird, Murrysville, Pa. (51). **G**

*Stewart, Fred. Carlton, Botanist, N. Y. Agric. Exper. Station, Geneva, N. Y. (44). 1901. **G**

*Stewart, George Walter, Professor of Physics, University of North Dakota, Grand Forks, N. Dak. (52). 1906. **B**

Stewart, James Henry, Director of W. Va. Agric. Exper. Station, Morgantown, W. Va. (50). **E**

*Stewart, Oscar M., Assist. Professor of Physics, University of Missouri, Columbia, Mo. (46). 1900. **B**

Stewart, Robert W., M. D., The Oritz, Cincinnati, Ohio. (51). **K**

Stickney, Gardner P., Wisconsin Trust Co., Milwaukee, Wis. (44). 1901. **H**

Stickney, Malcom Enos, Instructor in Botany, Denison University, Granville, Ohio. (53). **G**

*Stieglitz, Dr. Julius, University of Chicago, Chicago, Ill. (39). 1895. **C**

Stigall, Bennett Merriman, Director, Dept. of Biology, Manual Training High School, Kansas City, Mo. (53). **G**

*Stiles, Charles Wardell, Ph. D., Hygienic Laboratory, U. S. Public Health and Marine Hospital Service, Washington, D. C. (40). 1892. **F**

Still, George A., 603 W. Scott St., Kirksville, Mo. (50). **C**

Stillhamer, Arthur G., Yerkes Observatory, Williams Bay, Wis. (50). **B**

Stillman, Prof. John M., Stanford University, California. (41).

Stillman, Wm. O., M. D., 287 State St., Albany, N. Y. (28). **K**

*Stillwell, Lewis Buckley, 100 Broadway, New York, N. Y. (50). 1906. **B D**

*Stine, Prof. W. M., Swarthmore College, Swarthmore, Pa. (37). 1900. **A C**

Stockard, Chas. R., Columbia University, New York, N. Y. (52). **F**

*Stockton, Charles G., M. D., 436 Franklin St., Buffalo, N. Y. (51). 1906. **K**

*Stockwell, John N., 1008 Case Ave., Cleveland, Ohio. (18). 1875. **A**

Stoddard, George Howland, M. E., 197 Beacon St., Boston, Mass. (51). **D**

STOECKEL, CARL, Norfolk, Conn. (52). **A E**

*Stokes, Anson Phelps, 100 William St., New York, N. Y. (50). 1905. **I**

*Stokes, Henry Newlin, Ph. D., Bureau of Standards, Washington, D. C. (38). 1891. **C E**

*Stone, Alfred H., 201 A St. S.E., Washington, D. C. (51). 1905. **I**

*Stone, George E., Professor of Vegetable Pathology and Physiology, Massachusetts Agricultural College, Amherst, Mass. (48). 1902. **G**

*Stone, Miss Isabelle, Ph. D., Instructor in Physics, Vassar College, Poughkeepsie, N. Y. (50). 1906. **B**

*Stone, John S., Riverbank Court, Cambridge, Mass. (54). 1906. **B**

Stone, Julius F., Columbus, Ohio. (48).

Stone, Lincoln R., M. D., Newton, Mass. (31).
Stone, Mason A., 61 Pine St., New York, N. Y. (49).
*Stone, Ormond, Director Leander McCormick Observatory, University of Virginia, Charlottesville, Va. (24). 1876. A
*Stookey, Lyman Brumbaugh, Ph. D., University of Southern California, Los Angeles, Cal. (53). 1906. K
*Storey, Thomas Andrew, Assistant Professor of Hygiene, Stanford University, Cal. (52). 1906.
Storms, Albert Boynton, President Iowa State College, Ames, Iowa. (54). I
Storrs, Lucius S., Expert and Engineer of Tests, N. Y. N. H. & H. Railroad Co., New Haven, Conn. (51). E
*Story, Prof. Wm. E., Clark University, Worcester, Mass. (29). 1881. A
Stose, George W., U. S. Geological Survey, Washington, D. C. (52). E
*Stowell, Prof. T. B., Potsdam, N. Y. (28). 1885. F
*Stradling, George F., Northeast Manual Training School, Philadelphia, Pa. (41). 1900. B
Strange, William R., 1643 Octavia St., New Orleans, La. (55). K
*Stratton, Samuel W., Bureau of Standards, Washington, D. C. (52). 1906.
Strauss, Joseph, Lt.-Commander, U. S. N., U. S. S. Arkansas, care Postmaster, New York, N. Y. (54). D
Streeter, Miss Stella G., Teacher of Botany, Trenton High School, Trenton, N. J. (54). G
*Stringham, Irving, Professor of Mathematics, University of California, Berkeley, Cal. (51). 1906. A I
Strock, John Roy, 337 N. Hanover St., Carlisle, Pa. (54). B C
Stromsten, Frank A., Instructor in Zoology, State University of Iowa, Iowa City, Iowa. (52). F
Strong, Edwin A., Department of Physics and Chemistry, State Normal School, Ypsilanti, Mich. (46). B
Strong, Frederick F., M. D., 176 Huntington Ave., Boston, Mass. (47). B C K
Strong, Frederick G., Box 959, Hartford, Conn. (50). D
*Strong, Oliver S., Columbia University, New York, N. Y. (52). 1903. K
*Strong, Reuben Myron, Ph. D., Department of Zoology, University of Chicago, Chicago, Ill. (51). 1906. F
Strong, Richard P., Bureau of Science, Manila, P. I. (55). F
*Strong, Wendell M., care of Mutual Life, 32 Nassau St., New York, N. Y. (44). 1899. A B
Strong, William Walker, Mechanicsburg, Pa. (54). B
Stuart, William, Professor of Horticulture, University of Vermont, Burlington, Vt. (52). G

Stubbs, Joseph Edward, President, Nevada State University, Reno, Nev. (54).

*Stubbs, W. C., Ph. D., 1033 Carondelet Str., New Orleans, La. (40). 1901. F

*Sturgis, Wm. C., 28 E. Columbia St., Colorado Springs, Colo. (40). 1892. G

Sullivan, John J., M. D., 51 Passaic Ave., Passaic, N. J. (53). K

Sullivan, Lucien Norris, Instructor in Mining and Metallurgical Design, Lehigh University, Bethlehem, Pa. (54). D

Sullivan, Michael Xavier, Instructor in Physiology, Brown University, Providence, R. I. (55). K

Summa, Hugo, M. D., Professor of Medicine, St. Louis University, 2249 St. Louis Ave., St. Louis, Mo. (53). K

*Summers, Henry E., Professor of Zoology, State College, Ames, Iowa. (50). 1906. F

Summers, Joseph, 107 S. 6th St., Columbia, Mo. (51). B

*Sumner, Francis B., Ph. D., Instructor in Natural History, College of the City of New York, New York, N. Y. (51). 1906. F

*Surface, Frank Macy, Biological Hall, Univ. of Pennsylvania, Philadelphia, Pa. (53). F

*Surface, Harvey Adam, Professor of Zoology, Penna. State College, State College, Pa. (50). 1906. F

*Sutton, William John, Geologist, Esquimalt and Nanaimo Ry. Co., Victoria, B. C. (50). 1906. E

*Swain, Prof. Geo. Fillmore, Massachusetts Institute of Technology, Boston, Mass. (52). 1906. D

Swain, Joseph, Swarthmore, Pa. (54).

*Swartzell, Karl D., 308 West 8th Ave., Columbus, Ohio. (48). 1906. A

Sweat, Mrs. L. D. M., The Connecticut, Washington, D. C. (52).

*Swensson, Emil, C. E., 5511 Hays St., Pittsburg, Pa. (51). 1906. D

*Swezey, Goodwin D., Professor of Astronomy and Meteorology, University of Nebraska, Lincoln, Neb. (50). 1906. A

Swope, Gerard, Manager of the Western Electric Co., 810 Spruce St., St. Louis, Mo. (51). B D

*Symons, Thomas Baddeley, State Entomologist, College Park, Md. (54). 1906. F

Taber, G. Major, 508 Laughlin Bldg., Los Angeles, Cal. (51). E

*Taff, Joseph Alexander, U. S. Geological Survey, Washington, D. C. (54). 1906. E

TAFT, ELIHU B., Burlington, Vt. (36). H

*Tainter, Charles Sumner, 1335 Kalmia St., San Diego, Cal. (29). 1881. A B D

Tainter, Frank Stone, Civil Engineer, Far Hills, N. J. (51). D

*Talbot, Arthur N., Professor of Municipal and Sanitary Engineering University of Illinois, Urbana, Ill. (51). 1906. D

Talbot, Eugene Solomon, 103 State St., Chicago, Ill. (54).

*Talbot, Henry P., Mass. Institute of Technology, Boston, Mass. (44). 1896. C

Talbot, Miss Marian, LL. D., The University of Chicago, Chicago, Ill. (54). C K

*Talbot, Miss Mignon, Mount Holyoke College, South Hadley, Mass. (51) 1906. E

Talbott, Mrs. Laura Osborne, The Lenox, 1523 L St. N.W., Washington, D. C. (36). F G I

*Tallman, William Duane, Professor of Mathematics, State College, Bozeman, Mont. (50). 1906. A

*Talmage, James Edward, Ph. D., Professor of Geology, University of Utah, Salt Lake City, Utah. (50). 1906. E

*Tanner, Prof. John Henry, 7 Central St., Ithaca, N.Y. (47) 1899. A B

Tanner, Zera Luther, Commander, U. S. N., Retired, 2204 R St. N.W., Washington, D. C. (52).

*Tarr, Ralph Stockman, Cornell University, Ithaca, N. Y. (49). 1901. E

*Tatlock, John, Asst. Actuary, N. Y. Mutual Life Ins. Co. 141 Broadway, New York, N. Y. (50). 1902. A

Taussig, James, Rialto Bldg., St. Louis, Mo. (50). I

*Taylor, Alonzo Englebert, Professor of Pathology, University of California. Residence 1809 Broadway, San Francisco, Cal. (50). 1901. C K

Taylor, Charles E., 6 Wilbur Court, Cleveland, O. (54). C

*Taylor, Edson Homer, Teacher of Mathematics, Eastern Illinois State Normal School, Charleston, Ill. (53). 1906. A

Taylor, Edward B., Pittsburg, Pa. (50). D

*Taylor, Edward Randolph, Penn Yan, N. Y. (39). 1903. C

*Taylor, Edward Wyllys, M. D., Harvard Medical School, Boston, Mass. (50). 1902. K

*Taylor, Frank B., 548 Home Ave., Fort Wayne, Ind. (39). 1897.

Taylor, Henry W., Chief Engineer, House of Representatives, 100 Fifth St. N.E., Washington, D. C. (52). D

Taylor, H. Longstreet, M. D., 75 Lowry Arcade, St. Paul, Minn. (51). K

Taylor, J. Erskine, M. D., Rockland, Pa. (51). K

Taylor, James Landon, M. D., Wheelersburg, Ohio. (51). K

*Taylor, James M., Colgate University, Hamilton, N. Y. (33). 1901 A D

Taylor, Lewis H., M. D., 83 S. Franklin St., Wilkes-Barre, Pa. (51). K

Taylor, Robert S., Box 2019, Fort Wayne, Ind. (39).

Taylor, Wm. Alton, U. S. Department of Agriculture, Washington, D. C. (52). **G**

Tays, Eugene Aug. Hoffman, C. E., E. M., Consulting Mining Engineer, Fuerte, Sinaloa, Mexico. (50). **D E**

Teeters, Wilber John, State University of Iowa, Iowa City, Iowa. (50). **C F K**

Terry, B. T., M. D., Room 601, Hartley Hall, West 115th St., New York, N. Y. (54). **K**

*Terry, Robert James, Professor of Anatomy, Medical Department, Washington University, St. Louis, Mo. (53). 1906. **K**

*Tesla, Nikola, LL.D., 55 W. 27th St., New York, N. Y. (43). 1895. **B**

Tew, Miss Susan Dinsmore, Ph. D., Professor of Greek, H. Sophie Newcomb College, New Orleans, La. (55). **H**

Thaw, Benjamin, Morewood Place, Pittsburg, Pa. (50). **A D**

Thaw, Mrs. William, Box 1086, Pittsburg, Pa. (41). **H**

*Thaxter, Roland, Ph. D., Professor of Cryptogamic Botany, Harvard University, Cambridge, Mass. (50). 1901. **G**

*Thayer, William S., M. D., 406 Cathedral St., Baltimore, Md. (52). 1903. **K**

Thelberg, Elizabeth B., M. D., Resident Physician and Professor of Physiology and Hygiene, Vassar College, Poughkeepsie, N. Y. (50). **F K**

Thiessen, Alfred Henry, Mount Weather, Bluemont, Va. (51). **B**

*Thom, Charles, Agric. Exper. Station, Storrs, Conn. (50). 1901. **G**

*Thomas, Benjamin F., Professor of Physics, State University, Columbus, Ohio. (29). 1882. **A B**

Thomas, Jerome B., M. D., 769 De Graw Ave., Newark, N. J. (51). **K**

Thomas, Lancaster, 1932 Mt. Vernon St., Philadelphia, Pa. (52). **B F**

*Thomas, Prof. M. B., Wabash College, Crawfordsville, Ind. (41). 1894. **G**

Thomasson, A. H., M. D., 140 Boylston St., Boston, Mass. (53). **K**

Thompson, Almon Harris, 1729 12th St. N.W., Washington, D. C. (52).

*Thompson, Alton Howard, 720 Kansas Ave., Topeka, Kan. (33). 1902. **H**

Thompson, Miss Anna F., P. O. Box 32, Summit, N. J. (49).

Thompson, Benj., Chief Engineer, T. & B. V. Ry. Co., Hillsboro, Texas. (52). **D**

Thompson, Hugh L., Consulting Mechanical Engineer, Waterbury, Conn. (51). **D**

Thompson, James David, Library of Congress, Washington, D. C. (52). **A B**

Thompson, James E., 130 Howells Ave., Milwaukee, Wis. (48).
Thompson, James Edwin, 3224 Broadway, Galveston, Texas. (50).
Thompson, J. L., M. D., 232 N. Illinois St., Indianapolis, Ind. (39). F
*Thompson, Joseph Osgood, Amherst College, Amherst, Mass. (41). 1893.
Thompson, Millett Taylor, Ph. D., Clark University, Worcester, Mass. (51). F
Thompson, Robert M., 43 Exchange Place, New York, N. Y. (49).
Thompson, Rev. Walter, D. D., Garrison-on-Hudson, N. Y. (49).
Thompson, William, Mining, Metallurgical and Mechanical Engineer, Rossland Great Western Mines, Ltd., Rossland, B. C. (50). D E
*Thompson, W. Gilman, M. D., 34 E. 31st St., New York, N. Y. (50). 1902. F K
*Thomson, Elihu, Swampscott, Mass. (37). 1888. B
*Thomson, Wm., M. D., 1426 Walnut St., Philadelphia, Pa. (33). 1885. B
*Thornber, John J., Botanist, Agr. Exper. Station, Tucson, Arizona. (50). 1905. G
*Thornburg, Charles L., Lehigh Univ., S. Bethlehem, Pa. (44). 1897. A
*Thorndike, E. L., Ph. D., Adjunct Prof. of Genetic Psychology, Columbia Univ., New York, N. Y. (49). 1901. H I K
THORNE, MRS. PHOEBE ANNA, 558 Madison Ave., New York, N. Y. (50).
Thornton, William M., Professor of Applied Mathematics, University of Virginia, Charlottesville, Va. (53). A
*Thruston, Gates Phillips, Nashville, Tenn. (38). 1890. H
*Thruston, R. C. Ballard, Ballard & Ballard Co., Louisville, Ky. (36). 1896. E
Thurber, Charles Herbert, 29 Beacon St., Boston, Mass. (52). I
*Thwing, Charles Burton, Western Reserve Univ., Cleveland, Ohio. (54). 1906. B
Tibbals, Charles Austin, Jr., Instructor in Chemistry, Univ. of Wisconsin, Madison, Wis. (54). C
Tibbals, George Attwater, 148 Milton St., Brooklyn, N. Y. (51).
Tiffany, Lyman, 123 Pelham St., Newport, R. I. (52).
Tiffany, Louis C., 401 Fifth Ave., New York, N. Y. (50).
*Tight, William George, President University New Mexico, Albuquerque, N. M. (39). 1900. E
*Tilghman, B. C., 2210 St. James Place, Philadelphia, Pa. (54). 1906.
Tilley, Charles Edward, Teacher of Physics and Chemistry, Hope Street High School, Providence, R. I. (50). B C
*Tillman, Col. Samuel E., U. S. A., Prof. Chemistry, Mineralogy and Geology, West Point, N. Y. (54). 1906. B C E

Tilson, P. S., Associate Professor of Chemistry, A. and M. College, College Station, Tex. (50). **C**

*Tilton, Prof. John Littlefield, Simpson College, Indianola, Iowa. (50). 1906. **E**

*Tingle, Dr. J. Bishop, Johns Hopkins University, Baltimore, (50). 1903. **C**

*Titchener, E. B., Professor of Psychology, Cornell University, Ithaca, N. Y. (51). 1902. **H**

*Tittmann, Otto H., Supt. U. S. C. and G. Survey, Washington, D. C. (24). 1888. **A**

Titus, E., Jr., care of E. T. Roberts, Titusville, Pa. (50).

*Titus, E. S. G., U. S. Dept. of Agriculture, Washington, D. C. (50). 1906. **F**

Todd, Albert M., Kalamazoo, Mich. (37). **C**

*Todd, Prof. David, Director Lawrence Observatory, Amherst College, Amherst, Mass. (27). 1881. **A B D**

*Todd, Prof. James E., State Univ., Vermillion, S. Dak. (22). 1886. **E F**

Todd, J. H., M. D., Christmas Knoll, Wooster, Ohio. (48).

Todd, William J., M. D., Mt. Washington, Baltimore, Md. (51). **K**

Tompkins, Stonewall, M. E., Miller School, Va. (51). **D**

Tonnele, Theodore, Metallurgical Engineer, 919 College Ave., Pittsburg, Pa. (50). **E**

Toothe, William, Madison, N. J. (49).

*Torrey, Harry Beal, Ph. D., Instructor in Zoology, University of California, Berkeley, Cal. (52). 1905. **F**

Totman, David M., M. D., 303 Montgomery St., Syracuse, N. Y. (50). **K**

*Tower, Olin F., Ph. D., Assistant Professor of Chemistry, Adelbert College, Cleveland, Ohio. (50). 1903. **C**

*Tower, Ralph Winfred, Ph. D., Curator of Physiology, Am. Mus. Natural History, New York, N. Y. (53). 1905. **K**

Tower, William Lawrence, Zoology Bldg., Univ. of Chicago, Chicago, Ill. (55). **F**

*Towle, William Mason, Enosburg Falls, Vt. (44). 1902. **D**

*Townley, Sidney Dean, International Latitude Observatory, Ukiah, Cal. (53). 1906. **A**

*Townsend, Miss Anna B., 118 Lambert St., Philadelphia, Pa. (52). **F G**

*Townsend, Charles O., U. S. Dept. Agriculture, Washington, D. C. (46). 1902. **G**

*Townsend, Edgar Jerome, 501 John St., Champaign, Ill. (54). 1906. **A**

Townsend, John W., Room 1112 Arcade Building, Philadelphia, Pa. (54).

*Tracy, Samuel M., Biloxi, Miss. (27). 1881. **G**

Transeau, E. N., Ph. D., Dept. Biology, Alma College, Alma, Mich. (53). **G**

*Traphagen, Frank W., Ph. D., Professor of Metallurgy, Colorado School of Mines, Golden, Colo. (35). 1899. **C E F**

Trask, Spencer, William St. corner Pine St., New York, N. Y. (50). **I**

Treat, Erastus B., 942 St. Nicholas Ave., New York, N. Y. (29). **F I**

*Trelease, Wm., Ph. D., Director Missouri Botanical Gardens, St. Louis, Mo. (39). 1891. **G**

Tremoulet, J. Sydney, Local Manager, Grasselli Chemical Co., P. O. Box 1108., New Orleans, La. (55). **C**

Trimble, Robert E., Asst. Meteorologist and Irrigation Engineer, Agricultural College, Fort Collins, Colo. (50). **D E**

Trotter, Dr. Spencer, Swarthmore College, Swarthmore, Penna. (55). **E H**

*Trowbridge, Augustus, Ph. D., Dept. Physics, University of Wisconsin, Madison, Wis. (47). 1900. **B**

*Trowbridge, Charles Christopher, Tutor in Physics, Columbia University, New York, N. Y. (50). 1901. **B**

True, A. C., Ph. D., Director, Office of Experiment Stations, U. S. Dept. Agriculture, Washington, D. C. (52).

*True, Fred. W., U. S. National Museum, Washington, D. C. (28). 1882. **F**

*True, Rodney Howard, U. S. Dept. Agriculture, Washington, D. C. (46). 1899. **G**

Truesdell, George, Room 22, Wyatt Building, Washington, D. C. (49). **I**

Truman, James, D. D. S., Dept. of Dentistry, Univ. of Pennsylvania, 4505 Chester Ave., Philadelphia, Pa. (54).

Tucker, Miss Arabella H., Professor of Botany, State Normal School, Worcester, Mass. (54). **G**

Tucker, George M., Ph. D., Manager, Tucker Plant Breeding Farm, Blodgett, Mo. (53). **C**

Tucker, Colonel N. Beverley, Professor of Geology and Associate Professor of Chemistry, Virginia Military Institute, Lexington, Va. (55). **C E**

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Tucker, William Albert, Gunnison, Colo. (51). **G**

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*Turneaure, Frederic Eugene, Professor of Bridge and Sanitary Engineering, University of Wisconsin, Madison, Wis. (51). 1906. D

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Tutton, Charles H., Asst. Engineer, Department of Public Works, City Hall, Buffalo, N. Y. (53). D

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*Twitchell, E., Wyoming, Ohio. (39). 1891. C

*Tyler, Ansel Augustus, Ph. D., Professor of Science, Bellevue College, Bellevue, Neb. (50). 1906.

Tyler, Frederick Jared, U. S. Dept. of Agriculture, Washington, D. C. (54). G

*Tyler, Dr. Harry W., 491 Boylston St., Boston, Mass. (51). 1906.

*Tyrrell, Joseph Burr, Mining Engineer, Dawson, Y. T., Canada. (50). 1903. D E

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Van Patten, Edwin H., M. D., Dayton, Washington. (55). I K

*Van Slyke, Lucius L., Agr. Exper. Station, Geneva, N. Y. (41). 1901. C

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Wallace, Henry, Editor, Wallace's Farmer, Des Moines, Iowa. (54). **I**

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*Ward, Henry L., Director, Public Museum, Milwaukee, Wis. (51). 1906. E
Ward, J. Langdon, 120 Broadway, New York, N. Y. (29). I
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Warder, Prof. Robert B., Howard University, Washington, D. C. (19). 1881. B C
Wardle, Harriet N., 125 N. 10th St., Philadelphia, Pa. (47). E H
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*Ware, Wm. R., Milton, Mass. (36). 1901. D
*WARINGTON, ROBERT, F. R. S., Rothamsted, Harpenden, England. (40). 1899. C
Warman, P. C., Geological Survey, Washington, D. C. (53). G
*WARNER, JAMES D., 463 E. 26th St., Flatbush, Brooklyn, N. Y. (18). 1874. A B
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Warren, Geo. F., Jr., Agric. Expr. Station, New Brunswick, N. J. (52).
*Warren, Prof. Howard C., Princeton Univ., Princeton, N. J. (46). 1901. H K
*Warren, Joseph W., M. D., Bryn Mawr, Pa. (31). 1886. F
*Warren, S. Edward, Newton, Mass. (17). 1875. A I
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Warrington, James N., Honolulu, T. H., (34). **A B D**
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Washburn, George Hamlin, Prof. of Obstetrics, Tufts Medical School, Boston, Mass. (54). **K**
Washburne, Alva Courtenay, 1 Madison Ave., New York, N. Y. (54). **A**
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*Washington, Dr. Henry S., Locust, N. J. (44). 1897. **E**
Waterhouse, James Smartt, Professor of Chemistry and Natural Science, Cumberland University, Lebanon, Tenn. (50). **C F G**
*Waterman, Frank Allan, Prof. of Physics, Smith College, Northampton, Mass. (54). 1906. **B**
Waterman, Warren Gookin, Prof. of Physics and Geology, Fisk University, Nashville, Tenn.
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Waters, Theodore, 1196 Hewitt Place, New York, N. Y. (54). **I**
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Watson, Frank Elbert, De Pauw Univ., Greencastle, Ind. (51). **F**
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Watts, William Lawrence, Andover, Mass. (52). **A**
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Weaver, Edwin Oscar, Professor of Physics and Biology, Wittenberg College, Springfield, Ohio. (51). **B F G**
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Webster, Edgar H., Professor of Physical Science, Atlanta University, Atlanta, Ga. (50). **B**

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Weimer, Edgar A., M. E., Supt. Weimer Machine Works Co., Lebanon, Pa. (51). **D**

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Welin, John E., Professor of Physics, Chemistry and Geology, Bethany College, Lindsborg, Kansas. (50). **B C E**

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Wells, Eliab Horatio, M. D., Professor of Natural Science, Baylo-Female College, Belton, Texas. (50). **F K**

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*Westgate, Lewis Gardner, Ph. D., Professor of Geology, Ohio Wesleyan University, Delaware, Ohio. (51). 1906. E
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Westinghouse, Henry Herman, 2014 Trinity Bldg., New York, N. Y. (51). D
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*Wheeler, Henry Lord, Sheffield Scientific School, New Haven Conn. (50). 1901. C
Wheeler, Homer J., Ph. D., Director and Chemist, R. I. Exper. Station, Kingston, R. I. (54). C E
Wheeler, Horace Leslie, Department of Statistics, Public Library Boston, Mass. (52). A E
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*Wilcox, Edwin Mead, Ph. D., Prof. of Botany, Ala. Polytechnic Institute, Auburn, Ala. (50). 1901. F G

Wilcox, Miss Emily T., Middletown, Conn. (33). A B

Wilcox, Guy Maurice, Professor of Physics, Armour Institute, Chicago, Ill. (53). B

*Willcox, Miss Mary Alice, Ph. D., Professor of Zoology, Wellesley College, Wellesley, Mass. (50). 1901. F

*Willcox, Walter F., Ph. D., Professor of Economics, Cornell University, Ithaca, N. Y. (50). 1901. I

*Wilder, Burt Green, Prof. of Neurology, Cornell University, Ithaca, N. Y. (51). 1902. F

*Wilder, Harris Hawthorne, Ph. D., Professor of Zoology, Smith College, Northampton, Mass. (52). 1905. F

Wiley, Andrew J., Consulting Engineer, Boise, Idaho. (51). D

*Wiley, Harvey W., Ph. D., U. S. Dept. Agriculture, Washington, D. C. (21). 1874. C

*Wiley, William H., C. E., 43 E. 19th St., New York, N. Y. (50). 1906. D E

Wilkins, Miss Lewanna, Eastern High School, Washington, D. C. (52). F G

*Wilkinson, Levi Washington, Professor of Industrial and Sugar Chemistry, Tulane University, New Orleans, La. (50). 1903. C

*Willard, Julius Terrass, Dir. Kans. State Exper. Sta., Manhattan, Kans. (50). 1906. C

Wille, Henry Valentin, M. E., Engineer of Tests, Baldwin Locomotive Works, 500 N. Broad St., Philadelphia, Pa. (51). D

Willett, James R., 434 W. Jackson Blvd., Chicago, Ill. (53). D

*Williams, Benezette, 153 La Salle St., Chicago, Ill. (33). 1887. D

Williams, Charles B., North Carolina Dept. of Agric., Raleigh, N. C. (47).

*Williams, Charles H., M. D., 1069 Boylston St., Boston, Mass. (22). 1874.

Williams, Mrs. Chauncey P., 284 State St., Albany, N. Y. (52).

*Williams, Clarke Benedict, Prof. of Mathematics, Kalamazoo College, Kalamazoo, Mich. (54). 1906. A

*Williams, Prof. Edw. H., Jr., Andover, Mass. (25). 1894. D E

*Williams, Francis H., M. D., 505 Beacon St., Boston, Mass. (29). 1890.

Williams, Frank Blair, Ph. D., Assistant Professor Civil Engineering, Union College, Schenectady, N. Y. (53). D

Williams, Frank H., Greene, N. Y. (50). D

*Williams, Prof. Henry Shaler, Cornell University, Ithaca, N. Y. (18). 1882. E F

*Williams, Herbert U., M. D., Prof. of Pathology and Bacteriology, University of Buffalo, Buffalo, N. Y. (54). 1906. K

Willams, Ira Abraham, Iowa State College, Ames, Iowa. (52). D E

Williams, J. C., 221 Orchard St., Ridgeway, Pa. (51). E

Williams, Jacob Lafayette, M. D., 4 Walnut St., Boston, Mass. (51). K

*Williams, Dr. J. Whitridge, Professor of Obstetrics, Johns Hopkins University, Baltimore, Md. (50). 1901. F K

*Williams, Leonard Worcester, Brown University, Providence, R. I. (52). 1906. F

Williams, Miss Mabel Clare, Ph. D., State Univ. of Iowa., Iowa City, Iowa. (52). H

*Williams, Stephen Riggs, Professor of Biology, Miami University, Oxford, Ohio. (50). 1906. F

*Williamson, Edward Bruce, Bluffton, Ind. (50). 1906. F

Williamson, Homer D., M. D., Bank St., Lorain, Ohio. (51). K

Williamson, Mrs. M. Burton, University P. O., Los Angeles, Cal. (44). F

*Willis, Bailey, U. S. Geological Survey, Washington, D. C. (36). 1890. E

Willis, Bernard Darwin, care Stromberg-Carlson Telephone Mfg. Co., 70-86 W. Jackson Boulevard, Chicago, Ill. (52).

*Williston, Arthur L., Director Dept. Science and Technology, Pratt Institute, Brooklyn, N. Y. (51). 1906. D

*Williston, Dr. Samuel W., University of Chicago, Chicago, Ill. (51). 1902. F K

*Willoughby, Charles C., Peabody Museum, Cambridge, Mass. (45). 1897. H

*Wills, Dr. Albert P., Instructor in Mechanics, Columbia University, New York, N. Y. (53). 1906. A B

Wills, J. Lainson, F. C. S., Chief of Laboratories, National Brewers' Academy, New York, N. Y. (50). B F C

WILMARTH, MRS. HENRY D., West Boxford, Mass. (40).

Wilmore, John J., Professor of Mechanical Engineering, Ala. Polytechnic Institute, Auburn, Ala. (51). D

Wilson Miss Alisan, The Farragut, Washington, D. C. (52). H

Wilson, Prof. Andrew G., Hebron, Neb. (43). E

*Wilson, Charles Branch, State Normal School, Westfield, Mass. (52). 1906. F

*Wilson, Delonza Tate, Assistant Professor of Mathematics and Astronomy, Case School of Applied Science, Cleveland. Ohio. (53). 1906. A

*Wilson, E. B., Columbia University, New York, N. Y. (49). 1900.

Wilson, Fredk. Morse, M. D., 834 Myrtle Ave., Bridgeport, Conn. (51). K

Wilson, Prof. Frederick N., Princeton, N. J. (33). 1887. A D

*Wilson, Henry Van Peters, Professor of Biology, University of North Carolina, Chapel Hill, N. C. (50). 1901. F

Wilson, John C., Cosmos Club, Washington, D. C. (49). I

Willson, Mortimer, M. D., M. D., 6th & Water Sts., Port Huron, Mich. (50). A F

Wilson, Norman Richard, Lecturer in Mathematics, Wesley College, Winnipeg, Manitoba, Canada. (55). A

Wilson, Robert N., Macleod, Alberta, Canada (42). H

*Willson, Robert W., Cambridge, Mass. (30). 1890. A B

Wilson, William Hyatt, Prof. of Mathematics, Univ. of Wooster, Wooster, Ohio. (50). A

*Wilson, William Powell, Director Philadelphia Museums, 34th and South St., Philadelphia, Pa. (38). 1889. G

*Winchell, Alexander Newton, Professor of Geology and Mineralogy, State School of Mines, Butte, Mont. (50). 1903. E

*Winchell, Horace V., Butte, Montana. (34). 1890. C E

*Winchell, Prof. N. H., 113 State St., Minneapolis, Minn. (19). 1874. E H

Windesheim, Gustave, M. D., 255 Main St., Kenosha, Wis. (51). K

Windsor, Sarah Sweet, M. D., 138 Marlborough St., Boston, Mass. (47). **F H**

*Winslow, Charles Edward Amory, Instructor in Biology, Mass. Inst. Tech., Boston, Mass. (51). 1903. **F K**

Winston, Isaac, U. S. C. & G. Survey, Washington, D. C. (55).

Winter, Mahlon A., 339 Penna. Ave., Washington, D. C. (52): **D E I K**

Winterhalter, A. G., Commander, U. S. N., U. S. S. Paducah, care Postmaster, New York, N.Y. (37). 1893. **A**

Wiseman, Carl Marshall, Optician, 301 W. Chestnut St., Louisville, Ky. (53).

*Wissler, Clark, Ph. D., Am. Mus. Nat. Hist., 77th St. and 8th Ave., New York, N. Y. (54). 1906. **F**

*Withers, W. A., Professor of Chemistry, North Carolina College of Agriculture and Mechanic Arts, West Raleigh, N. C. (33). 1891. **C**

Witherspoon, Thomas A., Patent Office, Dept. of Interior, Washington, D. C. (52). **C**

*Witmer, Lightner, Ph. D., Asst. Prof. Psychology, Univ. of Pennsylvania, Philadelphia, Pa. (46). 1905. **H**

Witte, Max Ernest, M. D., Superintendent of Clarinda State Hospital, Clarinda, Ia. (51). **K**

*Witthaus, Dr. R. A., Cornell Medical College, 1st Ave. and 28th St., New York, N. Y. (35). 1890.

Woefel, Albert, M. D., Assistant in Physiology, University of Chicago, Chicago, Ill. (54). **K**

Woglum R. S., N. C. Dept. Agriculture, Raleigh, N. C. (54). **F**

Wolcott, Edson Roy, Prof. of Physics, Colorado School of Mines, Golden, Colo. (54). **B**

Wolf, August S., Examiners' Room, Equitable Life Assurance Society, 120 Broadway, New York, N. Y. (49).

Wolfe, Elmer Ellsworth, Ph. D., Principal of the Academy, Marietta College, Marietta, Ohio. (51). **B C G**

Wölfel, Paul L., 362 Green Lane, Roxborough, Philadelphia, Pa. (51). **D**

*Wolff, Frank A., Ph. D., Bureau of Standards, Washington, D. C. (47). 1900. **B**

*Wolff, Dr. John E., University Museum, Cambridge, Mass. (36). 1894. **E**

*Woll, Fritz Wilhelm, 424 Charter St., Madison, Wis. (42). 1897. **C**

Wolverton, Byron C., Engineer, N. Y. & Pa. Telephone and Telegraph Co., 321-323 Montgomery St., Syracuse, N. Y. (50). **D**

*Wood, Arthur J., State College, Pa. (51). 1905. **D**

Wood, Mrs. Cynthia A., 117 W. 58th St., New York, N. Y. (43).

Wood, Miss Elvira, 1425 Welling Place, Washington, D. C. (47).

Wood, R. Francis, 410 S. 15th St., Philadelphia, Pa. (54).
*Wood, Stuart, 400 Chestnut St., Philadelphia, Pa. (51). 1906.
*Wood, Thomas D., M. D., Prof. of Physical Education, Teachers' College, Columbia University, New York, N. Y. (51). 1902. K
Wood Walter, 400 Chestnut St., Philadelphia, Pa. (33). F I
Woodberry, Miss Rosa Louise, Teacher of Natural Science, Lucy Cobb Institute, Athens, Ga. (51). B C
*Woodbridge, Frederick J. E., Professor of Philosophy, Columbia University, New York, N. Y. (52). 1905. H
*Woodbury, C. J. H., Amer. Telephone and Telegraph Co., 125 Milk St., Boston, Mass. (29). 1884. D
Woodbury, Frank, M. D., 218 South 16th St., Philadelphia, Pa. (52). K
Woodhull, Brig. Gen. Alfred A., U. S. A., Retired, 46 Bayard Lane, Princeton, N. J. (51). K
*Woodhull, John Francis, Teachers' College, Morningside Heights, New York, N. Y. (43). 1899.
Woodhull, Gen. Maxwell Van Zandt, U. S. A., 2033 G St., N.W., Washington, D. C. (52).
*Woodman, Durand, Ph. D., 127 Pearl St., New York, N. Y. (41). 1896.
Woodruff, Major Charles Edward, Surgeon, U. S. A., Plattsburgh Barracks, N. Y. (54). H I K
Woodruff, Lorande Loss, Instructor in Biology, Williams College, Williamstown, Mass. (52). F
*Woods, Albert F., U. S. Dept. Agric., Washington, D. C. (43). 1897. G
Woods, Carl Fred, Dartmouth College, Hanover, N. H. (53). C
*Woods, Charles D., Professor of Agriculture, University of Maine, Orono, Maine. (50). 1901. G
*Woods, Frederick Adams, M. D., 1006 Beacon St., Brookline, Mass. (51). 1902. K
*Woodward, Prof. Calvin M., Washington University, St. Louis, Mo. (32). 1884. A D I
*Woodward, R. S., President, Carnegie Institution, Washington, D.C. (33) 1885. A B D
*Woodward, Samuel B., M. D., 58 Pearl St., Worcester, Mass. (51). 1906. K
Woodward, William Carpenter, E. E., 5 Charles Field St., Providence, R. I. (50). C D
*Woodworth, C. W., Asst. Professor of Entomology, University of California, Berkeley, Cal. (50). 1906. F
Woodworth, George Keen, Councillor at Law, 31 State St., Boston, Mass. (50). D

*Woodworth, Jay Backus, Assistant Professor of Geology, Harvard University, Cambridge, Mass. (54). 1906. E

*Woodworth, R. S., Ph. D., Columbia University, New York, N. Y. (49). 1901. H K

*Woodworth, William McMichael, Ph. D., 149 Brattle St., Cambridge, Mass. (44). 1898. F

Woollen, William Watson, 601 Commercial Club, Indianapolis, Ind. (55). F

Woolley, Paul G., Serum Laboratory., Bureau of Government Laboratories, Manila, P. I. (55). C

Wooster, Lyman Child, Ph. D., Prof. Biology and Geology, State Normal School, Emporia, Kans. (54). E F

*Worcester, Dean C., U. S. Philippine Commission, Manila, P. I. (46). 1903. F H

Wren, Christopher, Plymouth, Pa. (54). H

*Wright, Prof. Arthur W., Yale University, New Haven, Conn. (14). 1874. A B

*Wright, Carroll D., LL. D., President, Clark College, Worcester, Mass. (41). 1894. I

*Wright, Cary, Box 130, Denver Colo. (51). D

*Wright, Fred. Eugene, Ph. D., U. S. Geological Survey, Washington, D. C. (52). 1906. E

*Wright, Prof. Geo. Frederick, Drawer C, Oberlin, Ohio. (29). 1882. E H

*Wright, John S., Eli Lily & Co., Indianapolis, Ind. (42). 1899. G

Wright, Jonathan, M. D., 44 W. 49th St., New York, N. Y. (43). K

*Wright, Walter C., 45 Milk St., Boston, Mass. (54). 1906. A

*Wright, Walter Livingston, Jr., Professor of Mathematics, Lincoln University, Pa. (50). 1906. A

*Wrinch, Frank Sidney, Ph. D., Instructor in Experimental Psychology, Univ. of California, Berkeley, Cal. (52). 1906. H K

Wuensch, Alfred F., 1220 Corona St., Denver, Colo. (50). C D E

WUNDERLICH, FREDERICK W., M. D., 165 Remsen St., Brooklyn N. Y. (45).

Würtele, John Hunter, 1807 Pacific Ave., Spokane, Wash. (48)

*Würtele, Rev. Louis C., Acton Vale, P. Q., Canada. (11). 1875. E

*Wurts, Alexander Jay, Prof. of Applied Electricity, Carnegie Technical Schools, Carnegie Institute, Pittsburg, Pa. (50). 1906. D

*Wyckoff, Lieut. Ambrose Barkley, U. S. N., Retired, Port Townsend, Wash. (54). 1906.

*Wylie, Robert Bradford, Prof. of Biology, Morningside College, Sioux City, Iowa. (53). 1905. G

*Wyman, Walter, M. D., Surgeon-General, Public Health and Marine Hospital Service, Washington, D. C. (51). 1903. K

Yale, Leroy Milton, M. D., 432 Madison Ave., New York, N. Y. (54). K

*Yanney, Benjamin F., Prof. Mathematics and Astronomy, Mt. Union College, Alliance, Ohio. (51). 1906. A

*Yarrow, Dr. H. C., 814 17th St. N.W., Washington, D. C. (23). 1874.

Yates, J. A., Professor of Natural Science, Ottawa University, Ottawa, Kan. (50). B C G

Yates, Lorenzo Gordin, Ph. D., President, Soc. Nat. History, Santa Barbara, Cal. (54). E F G H

*Yerkes, Robert Mearns, Instructor in Comparative Psychology, Harvard University, Cambridge, Mass. (52). 1905. K

Yothers, W. W., U. S. Dept. of Agriculture, Washington, D. C. (55). F

Young, Miss Anne Sewell, Mt. Holyoke College, So. Hadley, Mass.

*Young, A. V. E., Northwestern University, Evanston, Ill. (33). 1886. B C

*Young, C. A., Hanover, N. H. (18). 1874. A B D

Young, Clinton Mason, Hiram, Ohio. (51). K

Young, Hugh Hampton, M. D., 1005 N. Charles St., Baltimore, Md. (53).

*Young, Stewart Woodford, Asst. Professor of Chemistry, Stanford University, Cal. (50). 1901. C

Young, Walter Douglas, E. E., B. & O. R.R. Co., 309 Oakdale Road, Roland Park, Baltimore, Md. (51). D

Zahm, George, Assistant Professor of Law, Yale University, New Haven, Conn. (53). I

*Zalinski, E. L., U. S. A., 201 East 16th St., New York, N. Y. (36). 1891. D

Zeigler, J. L., M. D., Mount Joy, Pa. (52). C G K

*Zeleny, Charles, Indiana University, Bloomington, Ind. (53). 1905. F

*Zeleny, John, Associate Professor of Physics, University of Minnesota, Minneapolis, Minn. (50). 1901. B

Zintheo, Clarence J., Prof. Agrl. Engineering, Iowa State College, Ames, Iowa. (54). D

*Ziwet, Alexander, 644 S. Ingalls St., Ann Arbor, Mich. (38). 1890. A

Zuber, Wm. H., Jeanette, Pa. (52). B C

INCORPORATED SCIENTIFIC BODIES.

[Holding membership under the provisions of Article 3 of the Constitution.]

Arizona, The University of, Library, Tucson, Arizona. (54).
California, The University of, Library, Berkeley, Cal. (52)
Cincinnati, Public Library of, Cincinnati, Ohio. (53).
Earlham College Science Club, Earlham College, Richmond, Ind. (54).
Iowa State University Library, Iowa City, Iowa. (54).
Jersey City Free Public Library, Jersey City, N. J. (52).
Manchester Institute of Arts and Sciences, Manchester, N. H. (48).
Marietta College Library, Marietta, Ohio. (51).
Michigan State Normal College, Ypsilanti, Michigan. (53).
Mt. Carmel Scientific Society, Mt. Carmel, Ill. (50).
Nebraska, The University of, Library, Lincoln, Neb. (51).
N. P. Coburn Library, Colorado College, Colorado Springs, Colo. (53).
Ohio State University Library, Columbus, Ohio. (54).
Philadelphia, The Free Library of, 1217–1221 Chestnut St., Philadelphia, Pa. (51).
P. M. Musser Public Library, Muscatine, Iowa. (51).
Pratt Institute Free Library, Ryerson St., Brooklyn, N. Y. (52)
St. Olaf Library, Northfield, Minn. (52).
Western Illinois State Normal School, Macomb, Ill. (55).
Wilmington Institute Free Library, Wilmington, Del. (52).

SUMMARY:

Corrected to May 1, 1906

Surviving Founders, 2; Patrons, 2; Honorary Fellows, 3; Fellows, 1864; Members, 2486; Total, 4357.

NOTE.—The omission of an address in the foregoing list indicates that letters mailed to that last printed were returned as uncalled for. Information of the present address of the members so indicated is requested by the PERMANENT SECRETARY.

DECEASED MEMBERS.

[A list of deceased members of the Association, so far as known at the time of publishing the volume of Proceedings of the Springfield meeting, May ,1896, is given in that volume. At the Buffalo meeting the Council directed the Permanent Secretary to omit the printing of the full list of deceased members in the annual volumes and to print only the additions to the list. Since the publication of the list printed in the Philadelphia Proceedings (Vol. 54), notices have been received of the decease of the following members.]

Arnold, Mrs. Francis B., 101, W. 78th St., New York, N. Y. (49). Died May 9, 1904.

Brown, Ellis W., 924 24th St., N. W., Washington, D. C. (52). Died July 4, 1905.

Carter, Henry C., 491 Bradford St., North Andover, Mass.(50).

Carter, James, Rawlins, Wyoming. (50). Died Nov. 17, 1904.

Catt, George William, Park Row Building, New York, N. Y. (51).

Cooper, Edward, 12 Washington Square, N., New York, N. Y. (49). Died February 25, 1905.

Curtis, Charles B., 9 East 54th St., New York, N. Y. (50). Died March 25, 1905.

de Funiak, Frederick, 204 E. Chestnut St., Louisville, Ky. (51).

Frazier, B. W., Lehigh University, South Bethlehem, Pa. (24). Died January 4, 1905.

Gordon, Leonard J. Jersey City, N J. (52).

Greene, David Maxson, 41 First St., Troy N. Y. (54). Died November 9, 1905.

Harper, William R., University of Chicago, Chicago, Ill. (53).

Harrison, Robert Henry, Columbus, Texas. (50). Died October 17, 1905.

Haupt, Herman, The Concord, Washington, D. C. (51).

Ketchum, Alexander P., 32 Mt. Morris Park. W., New York, N.Y. (45)

Langley, S. P., Smithsonian Institution, Washington, D. C. (18).

Laudy, Louis H., Columbia University, New York, N. Y. (28). Died August 17, 1905.

Matthews, Washington, 1262 New Hampshire Ave., Washington, D. C. (37).

Mellish, Ernest Johnson, El Paso, Tex. (52).

Mullin, Edward Hemphill, 44 Broad St., New York, N. Y. (52).

Ogden, Herbert G., U. S. Coast & Geodetic Survey, Washington, D. C. (38).

Peckham, Wheeler H., 80 Broad St., New York, N. Y. (36). Died September 27, 1905.

Prefontaine, Louis A., 317 Main St., Springfield, Mass. (52) Died June 19, 1905.

Sellers, William, 1600 Hamilton St., Philadelphia, Pa. (51). January 24, 1905.

Torrence, Wm. Wilson, 469 Main St., Deadwood, S. Dak. (51). Died February 13, 1906.

Trowbridge, Luther H., 13 Madison Ave., Detroit Mich. (29).

Turner, J. Spencer, 86-88 Worth St., New York, N. Y. (43) Died September, 1905.

Walker, Geo. C., Room 367 Rookery Building, Chicago, Ill. (17). Died April 12, 1905.

Warden, Albert W., 325 Fulton Street, Weehawken, N. J. (51).

Webb, Howard Scott, Univ. of Maine, Orono, Maine. (50). Died June 12, 1905.

Williams, Harvey Ladew, P. O. Box 410, Bristol, Tenn. (53). Died August 4, 1905.

Williamson, G. N., 14 Dey St., New York, N. Y. (49). Died April 27, 1905.

Wood, Matthew P., 316 W. 45th St., New York, N. Y. (51). Died December 23, 1905.

Wright, Albert A., Oberlin College, Oberlin, Ohio. (24). Died April 2, 1905.

ADDRESS

BY

THE RETIRING PRESIDENT OF THE ASSOCIATION.

ADDRESS

BY

W. G. FARLOW,

THE RETIRING PRESIDENT OF THE ASSOCIATION.

THE POPULAR CONCEPTION OF THE SCIENTIFIC MAN AT THE PRESENT DAY.

We are so accustomed to hear reports on the progress of science that we have almost ceased to ask ourselves what we mean by progress. What is or is not progress depends of course on the point of view. Some are so far ahead of the majority that they can not see how much progress is made by those behind them, others are so far in the rear that they can not distinguish what is going on ahead of them. We must also admit that there are different directions in which progress may be made. You have all seen the agile crab and been surprised to find how rapidly he gets over the ground, although he never seems to go ahead, but to scramble off sideways. The crab, perhaps, wonders why men are so stupid as to try to move straight forward. It is a popular belief, but, not being a zoologist, I am not prepared to vouch for its correctness, that the squid progresses backward, discharging a large amount of ink. One might perhaps ask: Is the progress of science sometimes like that of the crab, rapid but not straight forward, or, like the squid, may not the emission of a large amount of printer's ink really conceal a backward movement? So far as the accumulation of facts is concerned, there is a steady onward progress in science and it is only in the unwise or premature theorizing on known or supposed facts that science strikes a side track or even progresses backward.

As far as botany is concerned the progress during the past year has not been startlingly rapid, but it has been in the direction of an accumulation of facts rather than in the formulation of new theories, and the enunciation of general principles, very important if true, but unfortunately not always true, as time shows. If there have been no remarkable discoveries in botany during the past year, on the other hand it may be said that few of the steps which have been taken will need to be retraced hereafter. What strikes one most in a survey of the botany of the present day is, I think, the fact that it is becoming more and more difficult to say just what is and what is not botany. Formerly all botanists were cast in pretty much the same mold and, as a science, botany was sharply limited except, perhaps, in the direction of zoology. One could pass for a very good botanist, although quite ignorant even of the rudiments of other branches of science. Now we often see in botanical journals, papers which might almost as well have appeared in physical or chemical journals, and in many cases one is not at liberty to form a final opinion as to the value of a paper purporting to be botanical until physicists or chemists, or perhaps both, have also expressed their opinions in regard to it.

In short, the hard and fast lines which formerly shut botanists up in a world of their own have been broken down and botany has become an inseparable part of a broader science. This enlargement of the botanical horizon, resulting from the gradual shading off of the confines of botany into the domain of other sciences, not only tends to make it more attractive to botanists themselves, but also serves to add dignity to botany in the eyes of those who are not themselves botanists. Young botanists with a modern training may be permitted to feel confidence in entering on so broad a field, but those who are no longer young and whose training was that of the old school, no matter how much they may sympathize with modern conditions, can not help feeling distrustful of their ability to judge critically of work done in so many new directions and by so many diverse methods. Botany has, in fact, become so broad a science compared with what it was not many years ago, that no one man can be expected to be in position to judge critically of work

done except in certain branches of the subject. Consequently there have been formed a number of societies, each devoted to a special department of botany, and, if one wishes to know what is going on in botany, one is forced to attend the sessions of the societies affiliated with the Association as well as those of our botanical section. It is to the presiding officers of those societies and of the botanical section that one must look for anything like adequate presentations of the present state of botany. The views of one man are not sufficient, but he who would acquire a broad view must listen to the representatives of different branches. It seemed better, therefore, that, departing from the practice of my predecessors, I should not attempt what can be done better by others, and I have selected for my subject not the present condition of botany, but another topic which ought to interest us all, viz., the scientific man, what he is believed by the public to be and what he really is. Do not, however, suppose that I am about to regale you with personalities concerning my contemporaries. I wish merely to call your attention to the estimate which the public places on scientific men as a body and to consider the question whether they really understand the aims and needs of persons like ourselves.

You must have noticed in reading the magazines and papers that a change has recently come over the public in their attitude towards us. They believe that they have really discovered what we are; they recognize that we are more respectable than they used to suppose and the question has been asked more than once: What shall we, the public, do to help scientific men? That that question should be correctly answered is certainly of extreme importance to us. It is, therefore, worth our while to consider the recent change in the attitude of the public toward us, the question how far that attitude is correct from our point of view, and how far their ideas of what should be done for us correspond with what we really desire and need.

First, what do they think of us? The lights, or the supposed lights of science, have always been objects of interest to the world. The mass of scientific men have, on the other hand, counted for little. The public have always needed some idols to worship and in their indiscriminate collection of gods there have

always been a few taken from the scientific world. Their wonderful achievements have been magnified beyond all recognition, their precocious sayings have been recorded and their opinions on theology, music, politics and many other subjects about which they knew nothing in particular, have been paraded before us. Once in a while, when the flashlight of the caricaturist has been thrown upon them, they have been shown to have some human weaknesses, and the learned professor who is supposed to be discussing evolution or the vortex theory with his neighbor at some fashionable reception, has been represented as really only making remarks about the ladies present while imbibing fluids which it is said retard rather than aid the metamorphosis of brain tissue. Those who were not so fortunate as to be counted among the lights of science were passed over as having perhaps an academic importance, but of no account in the real world, being both impractical and impecunious. The question, what is the good of science, was supposed to be unanswerable, and it seemed to follow as a corollary that a man who spent his time on things which were good for nothing must himself be good for nothing.

All that has changed and the traditional scientific man has disappeared almost as completely as the traditional Yankee of the stage. The change came gradually but the proof that it had come was brought before us suddenly. In 1902 there was called in New York a meeting of those who were designated by the picturesque expression, captains of industry. To that meeting representatives of science were invited, not as lions to be stared at, but to sit with the leaders of the industrial and commercial world as representatives of science, and not only of applied science, but of pure science. As the captains of industry were supposed to be men of force in organizing and to have a keen insight into men and things, we had a right to feel that science was honored, perhaps not more than ever before, but for a reason for which it had not been honored before in this country. The fact that since that date the reputation of some of the captains of industry has suffered an eclipse, does not alter the fact that to be considered a captain of industry was, in the eyes of the public, enviable. The con-

ception of a scientific man as a captain of industry means simply the acknowledgement that science has a practical relation to the world, and that fortunately the public have advanced far enough to see, although perhaps somewhat dimly, that pure science sooner or later develops into applied science. The leaders of science are to be placed in the class of organizers, managers of a sort of scientific trust. This is science up to date and the public are right when they regard science as an organization. But they are only partly right. There is a good deal more than that in science, and, although good managers and directors are necessary, it is true that the power of organizing and the power of investigating are two different things and often exist in inverse ratio to each other, and it is the latter which is at the basis of science. An organizer is of no use until there is something to organize, and the materials on which the organizer in science must work are not made by machinery, but by the brains of individual workers, and it is important that they should be placed under the most favorable conditions for work. If hitherto there has been perhaps too little organization, there is a danger that in the future there may be too much. In a mill many men are doing the same kind of work, but in science one man should not duplicate the work of another. The object of organization in the one case is to secure uniformity of product, in the other to encourage diversity of work.

You have seen the statement in print that there are not enough workers in science, and it has been claimed that the rewards are so inadequate that many young men cannot afford to enter on a scientific career. It has been proposed to remedy that difficulty, and we not infrequently hear that something should be done by the public. So far nothing very definite has been proposed. It has been suggested that scientific men should be better paid. Against that we have absolutely nothing to say, but we are waiting a little impatiently to learn how they are to be paid. The captains of industrial establishments make large fortunes and it seems to be a principle of economy that in the management of other people's money a pretty large proportion finds its way into the pockets of the managers. Others who probably recognize the obstacles in the way of

arranging that scientific men shall be better paid would solve the difficulty by having a limited number of great prizes to be awarded at intervals.

It is certainly pleasant to know that the public would like to do something for us, for with the intention may come later the fulfillment. But it may be well to look into the matter a little more closely. In the first place, assuming that more men ought to go into science, it is by no means certain that, were the remuneration much greater, the right kind of men would go into the field. It would be an easy matter, if the pecuniary rewards were great enough, to induce any number of men to go into science, but a man in search of money is not ever likely to do the best work in science. Unless a man has a love of science for its own sake, apart from the money he is to make out of it, he must be classed as a business man and not a scientific man. A more important point to ascertain is how many men with a strong desire to study science and with good ability have been obliged to abandon its pursuit and gain their living in some other way. There are certainly some, but I am unable to form a definite idea as to the number. There are undoubtedly a good many men in the field struggling under difficulties which keep them from doing the best work of which they are capable. Before attempting to draw more men into the field it would be better to provide properly for those already in it.

Little need be said on the subject of a limited number of great prizes. So far, we are in the dark as to what the prizes are to be. We can not, of course, adopt the plan established in some countries and bestow on a few favored sons of science titles of nobility or knighthood. This method of reward merit has something to be said in its favor. It costs the bestower nothing and pleases the recipient. A chemist with a decoration 'round his neck is, of course, distinguished at once from other chemists. A physicist in knee-breeches and an embroidered coat is imposing, and, if a cocked hat under his arm be added, quite irresistible. But all this glory is not for us in this country—as yet. Nor can we expect that the coveted title of Geheimrath will be bestowed by our government. The

great prizes must necessarily be in the form of money, either as pensions or gifts. To have any real value a pension must be something of which both the amount and the date on which one may count with certainty on receiving it are fixed years in advance. To expect a pension, which some one else may receive, is hardly a consolation. If money is to be given outright how much is necessary to be considered a great prize? When we consider that even incompetent presidents of insurance companies consider their services cheap at a hundred thousand a year, one wonders what sum would be considered a proper reward for years of valuable work done by competent scientific men during the best years of their lives. Even at the best, the most that could be given to scientific men would be a mere pittance compared with what the other captains receive. It is unnecessary to try to answer the question, even if modesty did not forbid, for the principle of bestowing a few large prizes with the expectation of benefiting science is a delusion and it is to be hoped that no benevolent person will make the mistake of establishing one or more great prizes. What is wanted is not the possibility of some time receiving a large sum, but the certainty that the amount received annually will be sufficient to enable one to live and work without discomfort in the present and without anxiety for the future.

The ways in which the public may aid scientific men are directly by endowments for paying salaries and indirectly by providing properly equipped laboratories and other necessary equipment, and especially for paying for the services of assistants. Both forms of help are necessary, for a man capable of managing and getting the greatest amount of good work out of a well-equipped establishment deserves more than a meager salary. On the other hand, those with what appears to be a respectable salary may have to spend a good part of it to make good the deficiencies in their equipment. In deciding whether a man is well paid or not it is necessary to ask not only what salary he receives, but what are the means of work provided for him. It is not my intention here to call attention to the special ways in which scientific establishments would be benefited by gifts from the public nor to discuss the question

what is a proper salary for a scientific man. The latter depends upon too many complicated conditions and can not be separated from the more general question of what those in equally important positions in other walks of life are paid. The question of proper equipment, including the question of assistants, has already been brought before the public on a good many occasions and in a good many ways, and a good deal has been given in recent years, although by no means enough.

If, as it appears, the public have reached a better conception of the position of the scientific man in this country and of his pecuniary needs, it may be added that he has the right to hope that he can appeal to the public not only for pecuniary but for moral support, for, in many cases, the public are the final arbiters where differences arise, and unfavorable conditions often disappear quickly as soon as it is felt that one side or the other is backed by public opinion. It may, therefore, be well to state somewhat explicitly some of the conditions which are unfavorable to the progress of science in this country or which tend to retard it. Here it is not so much a question of money as of a just appreciation of the true position of scientific men in their relation to those for whom their work is undertaken. That work, using a rough classification, may be considered under three heads: that done in technical and commercial concerns, that done for the government, and that done in universities, including under that general term all colleges, scientific schools and similar institutions which have a permanent endowment of some kind.

In chemical, electrical and mechanical engineering works and other essentially commercial undertakings the scientific man is occupied mainly with routine duties, and the number of persons employed in this kind of work is large and will be much larger in the future. The ratio of demand and supply in this case must always regulate the salaries paid, and, as scientific experts are a necessity in these lines of business, the pay ought to be expected to be comparatively as good as in other branches of business. Occasionally, as we have seen recently in the case of electrical engineering, the supply may become suddenly

greater than the demand in the lower grades of work, but these things soon regulate themselves. Hitherto the value of biological work in connection with water-works and other hygienic establishments has not been as fully appreciated as it should be and the openings for specialists in biology have not been very numerous. There has been, however, a change for the better in this particular field. It is not, however, with the case of those whose work is what may be called routine work that we are concerned here, but we must ask why it is that, in those occupations which are primarily money-making, Americans have been so reluctant to employ original investigators for the purpose of developing their business. For a good many years the great value of original research in connection with manufacturing concerns has been fully recognized in some European countries. The Carlsberg laboratory at Copenhagen is a brilliant example of how much scientific work by experts of reputation can aid a practical industry, and we all know how the employment of experts to investigate special questions has helped the Germans to coin money in chemical industries. We shall have to admit that in certain respects we are more stupid than some other nations. I have heard of an important firm engaged in the manufacture of chemicals who could not be persuaded to employ a competent chemical investigator, not a mere analyst, to develop their business, because they felt unable to pay the princely salary of $1,500 a year. This is the same kind of stupidity which seeks to secure foreign trade by sending out agents who are unable to speak a word of the language of the country to which they are sent. If our business men are too stupid to take advantage of the help afforded by science, although informed as to what is done by their foreign competitors, we shall not be called on to shed many tears over their ultimate failure in the competition for business.

The relations of the national government to science and to scientific men are most important, but unfortunately very perplexing on account of the numerous complicated conditions which have to be considered. Although the government is concerned only incidentally with science, it has in its service more

scientific men than any other institution. I have said that the government was only incidentally concerned with science, believing that the object of government is to take charge of the work of administration entrusted to it by the constitution and acts of congress. Varied as this work may be, it does not include everything. For instance, the education of the country is fortunately not entrusted to the national government, and the business of education belongs to the states and the people in general. The theory that any department or departments of the government are to serve as universities for the scientific training of young men is, it seems to ~~me, false~~. The government may properly give information to the public on certain questions and, in this sense, it may be regarded as educational; but these questions arise in connection with definite special problems which necessarily affect the whole country, such as the subject of epidemic diseases of animals and plants and their prevention; questions concerning the preservation of forests; of irrigation and similar subjects which from their nature are of immediate national importance. This view, however, is not accepted by many, perhaps a majority, of scientific men connected with the government. There is something in the air of Washington which seems to makes it inevitable that those in the government employ should believe that it is the business of the government to undertake or control all scientific work. In some cases this belief has been carried so far that attempts of the States or universities to carry on explorations or special investigations have been regarded as an encroachment on the field belonging by right to the government, and no sooner has some university or private person sent out a party of explorers than a rival party has been sent out from Washington.

There is a tendency to forget that there are several millions of people in the United States not connected with the government, and that large sums are furnished by institutions and private individuals for the study of scientific questions which can perfectly well be investigated without supervision from Washington.

It has been said that the government has at its disposal more money than any state or institution, and therefore it is better

able to do all kinds of scientific work. This conclusion does not necessarily follow from the premises, for the questions arise: Is the money voted by Congress as likely to be spent economically as the amounts available in institutions not under government control, and, in general, is the concentration of scientific work under the government as advantageous for the development of science in this country as a proper distribution of the work among a number of independent institutions? Outside Washington there is a belief that, in accomplishing scientific work, a given amount appropriated by a university or other endowed institution will go farther than the same amount obtained by vote of Congress. In its fiscal arrangements the government treats the appropriations for scientific purposes as a part of a general budget, and the annual appropriations which become available in July lapse unless spent before the following July. Suppose then it is estimated that a given scientific investigation will require a certain amount of money. If that amount is voted it must be spent before the end of the fiscal year, and there is no doubt that it will be spent in some way or other. But, unfortunately, scientific investigations usually require a good deal of time and often very much more time than was anticipated. As a result, there must be additional grants, and to obtain them there is a great temptation to show that something has been done by printing reports of unfinished work. Outside the government departments, grants made for a special investigation do not lapse at the end of the fiscal year and such investigations can, therefore, be planned more intelligently and carried out at a less expenditure of money. Also, in the matter of printing, the expense under the government is very great, owing to the large editions which are necessary. In the case of the better scientific works with numerous plates, the great size of the edition, which must be larger than required to supply copies to those really competent to appreciate the work, implies a pecuniary waste.

But there is still the important consideration that in attempting to extend the work in too many directions, acting on the theory that the government should do all kinds of scientific work, the point is soon reached where no department and no

bureau can be expected to do the work well, and what might be done well suffers by being weighted with what can not be done well. We have seen bureaus which, after acting for some years on the theory that any question, theoretical or practical, which could possibly be construed as having any relation to its work should be undertaken, finally break down under the weight of the impossible task and at last settle down to their legitimate, special, practical work. If one glances over the large mass of scientific publications of the different departments, one can hardly fail to recognize that the most valuable are those which treat of special questions in applied science, which have been conducted with a view to furnish information on subjects coming within the legitimate limits of investigation by the government, since the material to be studied can be better obtained by the government than by state or private institutions. The publications on pure science or on subjects not having a practical bearing are certainly no better, if, as is sometimes the case they are as good as similar publications from other sources. Briefly, it seems to me that it would be no worse for the government and better for the science of the country in general if the scientific work done by the government were not spread over so wide a field. It will be said that the universities are also ambitious and attempt to do more than they can do well, which is perfectly true, but that is no reason why the government should make the same mistake.

The consideration of the attractions offered by scientific work under the government and the relations of the scientific corps to their superior officers is rather a delicate matter, for, while one may be allowed to speak of the advantages, as soon as one ventures to hint that there may be disadvantages, he is likely to be told that he does not understand the situation. We can only say that, if the scientific employees of the government are perfectly satisfied with their positions and regard them as ideal, they are decidedly more fortunate than their fellow scientists in other places. What attracts men to Washington is not primarily the salaries, except in the case of young men just beginning their scientific careers, although in general, salaries are not so small as has sometimes been supposed. Nor does the fact that

the few, like the heads of bureaus, who receive large salaries, are overwhelmed with administrative work prove that they are worse off than the better paid professors in universities where, until recently, with the higher salaries went more lecturing and more committee work. In the universities, however, this state of things is gradually improving, but it is difficult to see how it can change in the government departments. The salary which the average mean can expect is small and, if held to strict accountability for his time by the department in which he may be, he can not add to it by outside work or, if he does, he may be called upon suddenly to explain. The attractions are the freedom from lectures and class work, although this is to some extent counterbalanced by a large amount of official correspondence, and the possibility of having clerical and mechanical assistants to aid him in his work. A still greater attraction probably is the fact that one will at not infrequent intervals be sent, at government expense, on a mission of some kind to different parts of the country or abroad, an arrangement which relieves the monotony of routine work and enables one to see more or less of the world. In some universities the professors are allowed a year's absence once in seven years, but they are then generally on half-pay and have to provide for their own traveling expenses out of a reduced income.

There is supposed to be a certain glamour attached to the government positions in all countries, but, as far as scientific men are concerned, those in government employ have, like others, to depend for their reputation on their merits rather than on their positions. Even in the case of Germany, where it is generally supposed that official positions are more highly esteemed than in this country, to be a professor in one of the leading universities is a distinction as great as to be a government official, that is, in the capacity of a scientific worker. There is a certain class of men who would always find Washington more congenial than any other place. To them the interviewing of members of Congress and other officials is a pleasure. To them the newspaper correspondent is always welcome. Although they may have great scientific and administrative ability which enables them to accomplish a great deal of good

work, they are so constituted by nature that they never can be quite contented unless they have the opportunity of mixing in the stir and bustle of the world and being heard of men and seen of women. This class of men is a small one, and, I am inclined to believe, is growing smaller. It does not include the great majority of those whose work is of the most value to the government. This large majority prefer conditions which allow them to work in peace and quiet; and security of tenure in office, without the feeling that sooner or later there may be an overturning of some kind, is what they desire most in addition to adequate salaries.

This possibility of some unexpected change in policy is the great disturbing feature in Washington, and that such changes must occur sooner or later is inevitable because the atmosphere of Washington must always be political. This does not mean that the scientific men employed by the government need concern themselves with politics. In the past that may have been the case, but there is no reason to suppose that at the present day a botanist would have to be a Republican botanist or an entomologist a Democratic entomologist to be sure of his position. Nevertheless, politics must always be a disturbing element because the scientific workers must be assigned to some bureau of some department, and the secretaries, the heads of the departments, are always politicians and always will be. I do not intend to use the word in its degraded sense, although it might be going too far to use the word statesmen as applied to all secretaries. At any rate all will admit that they can hardly be expected to be scientific men or to have, except in very rare cases, any real knowledge of scientific subjects. They are appointed because they represent some political interest and change with the party and generally with the administration, so that their service is short. One secretary succeeds another at short intervals and the policy of one may not be the policy of another. One may believe that there can not be too much scientific work, another that science unless sordidly practical is worthless. The policy of launching out on scientific work of all kinds without regard to expense, on the ground that our country is rich and that there is no need of

counting the dollars and cents, is sure to be followed by indiscriminate retrenchment. In any case a secretary is obliged to look out for his own interests in relation to his party and in political crises no one can tell what may be done. Suppose that the presidents of all universities were changed once in four years and that the new presidents had power to change the policies of their predecessors at once. One could easily imagine that scientific work would suffer.

The permanency of tenure in the government is supposed to be secured by the civil-service regulations, and these regulations have undoubtedly improved the condition and raised the quality of government employees, but, so far as securing trained scientific men is concerned, the system, however well it may work in the case of clerks and low-grade positions, is not one which is so well adapted to the cases of positions requiring special scientific training. The recommendations of those under whom a man has studied, or for whom he has worked, would appear to be of more value than successful answers to a number of more or less stereotyped questions. The system, while it may keep out a very poor man, does not necessarily secure a very good man, unless, in some way unknown to us, the difficulties of a rigid system are softened by a beneficial interpretation of the rules. The civil-service system, although acting somewhat to the disadvantage of a scientific man so far as entering the service is concerned, is on the other hand undoubtedly a protection to him during his service.

A recent executive order, however, seems to us to be a most unfortunate step backward, and, whatever may be said, must inevitably cause a feeling of insecurity. From the somewhat vague accounts given in the papers at the time of its promulgation, one would perhaps not have been warranted in forming an opinion concerning the precise object which it was designed to accomplish, but the explanation of the order given in the President's message is, of course, authoritative. It is as follows:

"Heads of executive departments and members of the commission have called my attention to the fact that the rule requiring a filing of charges and three days' notice before an employee could be separated from the service for inefficiency,

has served no good purpose whatever, because that is not a matter upon which a hearing of the employee found to be inefficient can be of any value, and in practice the rule providing for such notice and hearing has merely resulted in keeping in a certain number of incompetents, because of the reluctance of heads of departments and bureau chiefs to go through this required procedure. Experience has shown that this rule is wholly ineffective to save any man, if a superior for improper reasons wishes to remove him, and is mischievous because it sometimes serves to keep in the service incompetent men not guilty of specific wrongdoing. Having these facts in view, the rule has been amended by providing that where the inefficiency or incapacity comes within the personal knowledge of the head of a department, the removal may be made without notice, the reasons therefor being filed and made a record of the department. The absolute right of removal rests where it always has rested, with the head of a department; any limitation of this absolute right results in grave injury to the public service."

The justice of the last sentence is beyond question. There is, however, another absolute, moral right which is not mentioned in this connection, viz., the right of a person accused to be heard in his own behalf by the one in whom the power of removal is vested. The expression, inefficiency or incapacity, coming within the personal knowledge of the head of the department, taken in connection with the previous statement that experience has shown that the rule requiring three days' notice is wholly ineffective to save any man, if a superior, for improper reasons, wishes to remove him, suggests several unpleasant possibilities. In the first place one regrets hearing that it is not only possible that persons might be removed for improper reasons, but especially that experience has already shown that the previous rule was powerless to prevent such removals. Stated baldly, experience has shown that persons have been removed for improper reasons since the establishment of the rule. By whom, one would like to ask? By the heads of departments in whom is vested the absolute power of removal? The expression, personal knowledge of the heads of departments, must, in the case of scientific employees, be taken to mean in-

direct rather than direct knowledge, since they are not themselves scientific men and must practically obtain their knowledge of one scientific subordinate from other subordinates; and this is an additional reason why, when it is a question of removing a scientific man, he should be allowed to state his case to the head of the department, and, if he is charged with misdemeanors of any kind, be informed by whom the charges have been made. It is evident that the new order has caused some criticism, since what was said in the message was not merely explanatory, but also in the nature of a defense. It is sincerely to be hoped that this order, embodying as it does a principle which may in practice cause injustice, may be revoked and something more specific and less sweeping be substituted for it. It is useless to say that there is no danger that the rule will be applied except in cases where the incompetency or indiscretion is quite plain. So long as it exists, knowing the weakness of human nature, there is always a danger that it may be applied in a way to cause injustice.

Turning to the universities and other similar endowed institutions we also find very perplexing conditions, but they have been discussed so frequently in print that the public is tolerably well informed in regard to them. If in the government departments the political atmosphere prevents the highest development of scientific life, in the universities the air is chilled, as far as scientific men are concerned, by the widely spread heresy that too much athletics is a good thing for a university. So long as a coach receives a higher salary than any professor, one is warranted in asking whether learning is too cheap or athletics too dear. Certainly on pay day professors would be glad to be classed with coaches. Is the craze for spectacular athletics ever going to pass away? Apparently not, for athletic contests, theatrical and similar non-academic diversions, are naturally more interesting than learning of any kind to a by no means small proportion of those who form the body of students. It is certainly a weak point in our universities that there have to be taken into account two different classes of men; those whose primary object is study and those whose interests are mainly or exclusively athletic and social.

It will be said that the line between the two is not a sharp one, but in the interest of learning it seems to me best that a line should be drawn, even if it has to be somewhat arbitrary. One should avoid, in general, making distinctions without differences, but, on the other hand, it should not be forgotten that in some cases the moral effect of making a distinction is to bring out the fact that there is a real difference. It would certainly be advantageous for scientific men, using the word in its broad sense, if the public could be given to understand clearly that in the universities a real distinction is made between the genuine student and the student *pro forma*. They would probably feel that the money they give is well spent if spent on the genuine student, while on the other hand they might be skeptical about the good of spending money on those who do not care to study more than they are forced to do to keep in college. To have it suspected that the universities are of a sort of Jekyl-Hyde nature, at one time all athletics, at another all study, would obscure their true position.

It is of great importance that the standard by which the value of a professor is estimated should not be the size of his classes and the number of his lectures. This method of estimating their value used to be universal, and, although the more enlightened part of the public have ceased to regard the number of students and lectures as the most important thing, the old way of estimating values is still far too prevalent. At the present day, the real distinction of a university depends more on the amount and quality of the higher work than on the amount of instruction of a low grade. It was supposed, a few years ago, that the universities and colleges would gradually differentiate themselves into classes; better endowed into institutions where the higher studies would be made prominent, while those with only a moderate endowment would confine their work to the instruction of undergraduates. But it is not likely that this will be the result. The advent of the multi-millionaire makes it possible that at any time some very rich man may leave his millions to one of the poorly endowed colleges. Since any college may succeed in capturing the millions, there is a new inducement to colleges to live beyond their

means rather than limit themselves to what they can do well with the money they actually have.

In the universities, as in the government departments, there is a disposition to branch out in too many directions and to believe that one university must try to do everything that other universities are trying to do. Sooner or later there must be some limitation to what any given university can expect to do; otherwise, since the amount of money which even the best endowed universities can expect will never be sufficient for them to do everything, some, if not many, of the branches of science must be kept on a starvation basis. The governing bodies of universities are altogether too much inclined to ask themselves the question, Is there not some new subject which can be introduced, without stopping to consider the more fundamental question whether the subjects already included in the curriculum are properly provided for?

Briefly, the main difficulties to be met with in the universities are, first, as we have seen, the organic connection of a studious and a non-studious body which would be remedied were it possible to draw the line between work of a low grade and the higher studies and place those in charge of the latter in an independent position. Two other difficulties are the excessive demand on the time and energy of the professors by lectures and class work and, in many cases, the insufficiency of the salaries. In a way, the two are phases of the same difficulty. If there were plenty of money both would disappear. Since so large a portion of the income of most universities is derived from students' fees, there is a tendency to pay the larger salaries to those having the larger classes, or, at least, those with large classes feel aggrieved that the fees should be spent largely on those in charge of the higher studies in which there must always be a few students. There is, it ~~seems to me~~, no better way of aiding universities than by endowing chairs in the departments of higher studies in which there can never be many students and where the amount obtained from fees is hardly worth considering.

Perhaps the most important question affecting the future not only of science in the limited sense, but of learning of all

kinds in this country, is that of the proper relation of the faculties of the universities to the trustees. That the question has come into prominence at the present time is due to the fact that, since in business the tendency is toward a greater concentration of power in a few hands, so, if we regard education as a business, the control of all educational questions should be in the hands of a few trustees. In the universities, however, there is the purely financial question of the management of the funds and the question of education considered from the intellectual side, and the two questions are not only essentially different in their nature, but also the training necessary for a business man is not the same as that necessary for one who is to be an educator and a scholar. To the trustees belongs the management of the finances and it would be preposterous to entrust purely business matters to a numerous body like the faculty even were they not unfitted for such work by their lack of proper training. To the faculty belong the practical work of education and the advancement of learning. The difficulty at the present time is that when it comes to the question of the general educational policy to be pursued, there is an increasing tendency on the part of trustees to assume that that is their business and not that of the faculty. Practically the board which controls the expenditure of money can, if it wishes, shape the policy without regard to the opinion of others. Whether it is better for education and learning that they should do so is another matter. Probably a large portion of the educated public are of the opinion that the faculty are better qualified than the trustees to decide educational questions both theoretical and practical, and they would certainly agree in thinking that no educational policy should be adopted without the concurrence of the faculty. It would surely be a misfortune should the public endorse the opinion said to be have been expressed recently by a trustee, that the faculty are merely the employees of the trustees and that their opinion is of no consequence, even in cases which seriously affect their work and their future. Furthermore, the farce of asking the opinion of a faculty when there was never the slightest idea of following it does not add to the dignity of either trustees or

faculty, nor does it tend to bring about the harmony of action necessary to success. The expression, only an employee, however, may not be quite so contemptuous as it at first seems, for, after all, the trustees themselves are only employees. They are not managing their own money on their own account, but are simply employed to carry out the intentions of those who have given their money to found and carry on different institutions of learning and they are responsible to the public for the way they perform their duties. They may not be paid in money, but they are paid in the honor of holding positions which are justly highly prized. Unless the public feel that they are administering their trusts wisely and in accordance with the intentions of those who have given the money, they will sooner or later cease to supply more funds and there is always need of more money.

It seems to me that the antagonism between the trustees and the faculty is really less marked than many suppose, and, if the opinions of the faculty are at times apparently disregarded, it may be in part, at least, because the trustees find it difficult to ascertain just what the collective opinion of the faculty is. In the larger universities the faculties are so large that, when meeting in a body, their discussions are apt to be very prolonged and not always to the point. It ought to be possible to contrive some way in which the views of both boards could be presented in a definite, practical way. In one of our universities, I understand, there is a joint board composed of some trustees and some members of the faculty, known as the committee on education, before which are brought questions in which both boards are intimately concerned, and the recommendations of this committee, it is said, have always, so far as known, been adopted by the trustees. The faculty members of such a board should of course be selected by the faculty itself and serve only for fixed intervals, in order that they may really represent the views of the majority of the faculty at any given time.

If in discussing the position of scientific men in this country I have given greater prominence to the conditions which tend to retard progress than to those which favor it, it is because I

believe that the first step toward the removal of obstacles is to state clearly what those obstacles are. It is not improbable that some evils will disappear as soon as it is generally recognized that they are evils. We have seen that the public are more interested than they were in the welfare of scientific men, and the better they understand existing questions, the better for us. If they now believe that organization and concentration are necessary in science, as in business, they should also understand that organization has its dangers as well as its advantages. While accepting the prevailing idea of the necessity of organization, we must, at the same time, insist that the future of science requires that a proper balance be maintained between general organization and individual independence. Furthermore, the organization needed in science does not consist in having scientific work placed under the control of purely business men, but of scientific men who have a capacity for administration, and such men can be found. Purely financial matters must be entrusted to non-scientific business men, but science itself is something different from business in the ordinary sense. Even when placed in charge of scientific men, it is important to avoid carrying the organization of science so far as to repress individual effort and bring about a sort of bureaucracy which resents unfavorable criticism and requires all work to conform to a fixed, narrow standard. Science should be a republic in which, with the approval of the majority of workers, the more capable become the rulers. Science should be well organized, but it should never become, in a purely business sense, a trust.

SECTION A.

Mathematics and Astronomy.

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ADDRESS

BY

ALEXANDER ZIWET.

VICE-PRESIDENT AND CHAIRMAN OF SECTION A FOR 1905.

THE RELATION OF MECHANICS TO PHYSICS.

In the historical development of mechanics the names of Galileo, Newton and Lagrange mark the principal epochs, each of the three periods, from Galileo to Newton, from Newton to Lagrange and from Lagrange to our time, covering roughly a century.

When Galileo in 1633, at the age of sixty-nine years, was forced by the prelates of Rome to abjure solemnly the truth of the Copernican system of the universe to the proof of which he had devoted the main efforts of a long and active life, he had still to write his most remarkable work, the 'Discorsi e dimostrazioni matematiche intorno à due nuove scienze attenenti alla mecanica et i movimenti locali' (1638).* He composed it while confined to a house at Arcetri, near Florence, under the close watch of the Inquisition, strictly forbidden to publish anything and struggling with ill-health and the infirmities of old age which were soon to deprive him completely of his eyesight. Considering these circumstances of its composition, the marvelous freshness and wealth of ideas of this work, which makes Galileo the first mathematical physicist, would be incomprehensible if we did not know from his correspondence

* It is to be regretted that there exists no good modern translation of this classical work. The German translation published in *Ostwald's Klassiker der exakten Wissenschaften* (Nos. 11, 24, 25,) while it contains some helpful notes, is not always exact and trustworthy. The original has recently been edited with great care by A. Favaro in Vol. VIII. (1898) of the 'national edition' of Galileo's Works.

that the materials for it had largely been in his mind ever since his early youth. If this be taken into account, the beginnings of both mechanics (apart from statics) and mathematical physics may be dated back to about the year 1600.

One of the two new sciences originated by Galileo in the 'Discorsi' is mechanics as the science of motion, especially in its application to falling bodies and projectiles. The genius of Newton, of Huygens, of Leibniz, was soon to prove the correctness of Galileo's prophetic insight in claiming for his speculations on motion the name of a new science. What Newton and his followers in the eighteenth century did for mechanics is too well known to be here rehearsed. By his careful formulation of the fundamental postulates and definitions and by his bold assumption of the law of universal gravitation, Newton laid the lasting foundations for astronomical mechanics; and his fluxional calculus opened up for this science a wide range of development.

The other of Galileo's two new sciences deals with the internal structure of matter and the so-called resistance of materials; it is the germ of the mechanics of deformable bodies. Progress along this line proved a far more difficult task. The seventeenth and eighteenth centuries contributed but little to the theory of elasticity. Indeed, a new mathematical tool, the theory of partial differential equations, had to be invented, and a physical phenomenon hitherto neglected, vibratory and wave motions, had to attract the attention of mathematicians, before the mechanics of deformable bodies could become a true science. Besides, the conception of mechanics itself had to be broadened; and this was accomplished by Lagrange in his «Mécanique analytique' (first edition 1788, second edition 1811-15).

In view of the use made in the course of the nineteenth century of Lagrange's generalizations (it may suffice to mention the theory of the potential, the Lagrangian equations of motion with their generalized idea of force, the general 'principles' such as the principle of least action) it is, I believe, not too much to say that Lagrange's work is as great an advance on Newton's as Newton's was on that of Galileo.

By the contemporaries of Lagrange this advance was perhaps not fully appreciated. We find the physicists of the beginning of the nineteenth century still very strongly attached to the idea that all natural phenomena not only may, but must, be explained on the basis of Newton's laws* by central forces acting instantaneously at a distance. Newton's mechanics had done such admirable service in astronomy that it had come to be regarded as the only possible means of describing and discussing the actions of nature. The gradual abandonment of this position, and the change to the modern view, according to which all actions in nature are transmitted through a continuous medium and require time for their transmission, was accomplished only after a long struggle that occupied the greater part of the nineteenth century.

The more or less conscious part taken in this struggle by *technical* mechanics, which in the same period developed into a science, has not always been insisted on sufficiently. Technical mechanics has always been free of the idea of central forces. To the engineer the idea of forces acting at a distance is completely foreign, in spite of the curious fact that, until not so very long ago, the typical example of such a force, gravitation was almost the only force with which he had to deal. The development of thermodynamics, which has given us the principle of the conservation of energy in its broadest aspect, was closely connected with the rise of technical mechanics, but proceeded rather independently of the development of the other branches of mathematical physics. Its fundamental principles are of a very general and abstract nature, and even where the molecular hypothesis is well worked out, as in the kinetic theory of gases, the idea of central forces is in no way essential.

Hydrodynamics, elasticity, optics, electricity and magnetism, though originally based on molecular hypotheses and the idea of central forces, in the course of their development found themselves more or less independent of these notions. In all of them the important common feature is the propagation of

* See, however, Laplace, 'Mécanique Céleste,' livre I., Chap. VI. ('Oeuvres,' Vol. I., 1878, pp. 74-79), a passage to which E. and F. Cosserat have recently called attention.

actions through a medium which can be regarded, at least in first approximation, as continuous. In hydrodynamics and in the theory of elasticity this medium is that unknown something which we call matter; in optics, and later in the theory of electricity and magnetism, it was found necessary to postulate the existence of another medium, the ether.

It is well known how the ideas of Faraday, of Maxwell, of Hertz, gradually gained ascendency over the older views and led to the abandonment of the idea of central forces acting instantaneously at a distance, in almost all branches of physics except in the theory of gravitation. It is also known that Maxwell, by a brilliant analysis, succeeded in establishing the connection between his electromagnetic theory and the analytical mechanics of Lagrange. Thus, at the end of the nineteenth century we find a general attitude toward physical phenomena essentially different from that prevailing at the end of the eighteenth century.

With the rise of the electron theory in the course of the last twenty-five years a new element has been introduced into this development, an element which seems destined to affect very radically not only our interpretation of physical phenomena, but also our general views about the principles of theoretical mechanics. The idea of the electron has grown out of the idea of ions as used in electrolysis. Each molecule of an electrolyte may break up into two ions, *i. e.*, two atoms, or groups of atoms, carrying equal and opposite charges. The current passing through the electrolyte then consists in the actual transfer of these ions to the cathode and anode to which they give up their charges. In his Faraday lecture, delivered in 1881, which marks an epoch in the ion theory, Helmholtz says: "If we accept the hypothesis that the elementary substances are composed of atoms, we can not avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity."

These 'atoms of electricity,' since encountered in a large number of more recondite phenomena, and often apparently free, *i. e.*, not attached to any matter in the ordinary sense, are

the *electrons*. Thus physicists have been led to return in a certain sense to atomistic conceptions, without however, abandoning the idea of the propagation of electric, magnetic and optical disturbances through the ether in time. Lord Kelvin, in his Baltimore lectures in 1884, gave expression to this tendency so largely developed in the succeeding twenty years. The very first words of his first lecture are: "The most important branch of physics which at present makes demands upon molecular dynamics seems to me to be the wave theory of light."

Without discussing the experimental basis of the electron theory it must here suffice to say that on the one hand the dispersion and diffraction of light, on the other the phenomena exhibited by cathode and canal rays, Röntgen rays, the Becquerel rays emitted by radium, etc., all find their ready interpretation in this theory.* At the same time, the electron theory as developed by Lorentz, Wiechert, Drude and others seems to furnish an excellent basis for the whole theory of electricity, magnetism and light.† Indeed, attempts have already been made of interpreting matter itself as an electromagnetic phenomonon and of explaining gravitation by means of this electron theory of matter.

It should be observed that the electron theory does not upset that beautiful structure known as the electromagnetic theory of Maxwell and Hertz. It merely modifies it to a certain extent so as to give a more detailed account of electromagnetic phenomena in ordinary matter. It is related to the older theory somewhat as the kinetic theory of gases is related to the theory of heat and of ordinary matter in general. The

* See, for instance, W. Kaufman, *Physikalische Zeitschrift*, 3 (1901), pp. 9 sq., translated in *The Electrician*, 48 (1901), pp. 95-97: O. Lodge, *Journal of the Institute of Electrical Engineers*, 32 (1902-3), pp. 45-115; P. Langevin, *Revue générale des sciences*, 16 (1905), pp. 257-276; H. A. Lorentz, "Ergebnisse und Probleme der Elektronentheorie," Berlin Springer, 1905.

† It will be sufficient to mention Lorentz's articles in the *Encyklopädie der mathematischen Wissenschaften*. V., 13, 14, where full references are given, and to the systematic work of M. Abraham, "Theorie der Elektrizität," I. (1904), II. (1905), Leipzig, Teubner.

kinetic theory assumes the laws of ordinary mechanics for the motion of the hypothetical molecule and then tries to determine the average affects arising from the motion of very large numbers of such molecules, these averages being the only thing actually observable. Similarly the electron theory must begin with postulating laws of motion for the single electron in the electromagnetic field and try to deduce the average effects due to swarms of electrons; the comparison of these calculated average effects with the results of observation and experiment must serve as verification of the postulated laws.

If, then, observation leads us to the assumption that electric charges may exist and move about without being attached to, or carried by, ordinary matter, what are the "laws of motion" of such an electron? As the moving object is not ordinary matter, we must not be astonished to find that Newton's laws of motion can not be applied blindly. The electron moves according to the laws of electrodynamics. We are thus confronted with the question as to the relation of the fundamental postulates of this science to those of ordinary mechanics.

An electric charge at rest manifests its presence only by the field which it excites in its vicinity, by the sheaf of lines of force issuing from it. To take a simple concrete example, a small charged sphere has lines of force radiating as if from its center in all directions, and the electric force, or intensity of the field, $\mathbf{E}$, at any point P, at the distance r from the centre of the sphere whose charge is e, has the direction of r and the magnitude e/r^2.

If the sphere is in motion it carries its field along almost unaltered, provided the velocity $\mathbf{v}$ of the sphere be small in comparison with the velocity of light. But it excites a magnetic field, the magnetic force, or intensity, being $\mathbf{H} = \mathbf{E} \times \mathbf{v}$; *i.e.*, the magnitude of the force at P is $= ev \sin (\mathbf{E}, \mathbf{v}) / r^2$, its direction is at right angles to $\mathbf{E}$ and $\mathbf{v}$, and its sense is such that the three vectors $\mathbf{E}$, $\mathbf{v}$, $\mathbf{H}$ form a right-handed set. The lines of magnetic force are, therefore, coaxial circles about the direction of motion.

According to the electromagnetic theory, the energy of the magnetic field is distributed throughout the field, with volume

density $(1/8\pi)\,\mu H^2$, where μ is the magnetic permeability of the medium. The energy of the whole field is readily obtained by integrading over the space outside the sphere; it is found $=\frac{1}{3}\mu e^2v^2/a$, where a is the radius of the sphere. This magnetic energy, being due to the motion of the charge, is analogous to kinetic energy.

If the charged sphere consists of an ordinary mass m carrying the charge e so that its ordinary kinetic energy is $\frac{1}{2}mv^2$, the total kinetic energy due to the motion of m and e with the velocity v is

$$T = \tfrac{1}{2}\left(m + \tfrac{2}{3}\mu\frac{e^2}{a}\right)v^2,$$

that is, the same as if the mass m of the sphere were increased by the amount $\frac{2}{3}\mu e^2/a$.

The result, then, is similar to that known in hydrodynamics for a sphere of mass m moving through a frictionless liquid. In moving, the sphere sets the surrounding liquid in motion; to move the sphere we have to set in motion not only the mass m, but also that of the liquid around it. Thus the sphere moves in the liquid just as a sphere of greater mass would move in vacuo. In the case of a sphere the mass is increased by one-half of that of the liquid displaced. But in the case of a body whose mass is not distributed as symmetrically as in the case of the sphere, the mass to be added depends on the direction of motion.

As the apparent mass of the charged sphere in motion, owing to the presence of the charge e, exceeds the ordinary mass m by $\frac{2}{3}\mu e^2/a$, the apparent momentum exceeds the ordinary momentum mv by $\frac{2}{3}\mu e^2v/a$; and this additional momentum must be regarded as residing not in the sphere but in the surrounding field. This momentum possessed by the field is what Faraday and Maxwell used to call the electrotonic state.

In the case of the free electron we have $m=0$; hence the total mass, momentum, kinetic energy, is magnetic and is distributed throughout the field. Moreover, if the velocity of the electron be comparable with the velocity of light, the apparent mass will depend not only on the direction, but also on the magnitude of this velocity.

Any variation in the velocity of the charged sphere, or of the

electron, produces a variation in the momentum of the field, which is propagated as a pulse through the field with the velocity of light. If such a pulse strikes a charged body at rest, the body acquires velocity and momentum, the momentum acquired being equal to that lost by the pulse. As the pulse resides in the ether, the law of the equality of action and reaction would make it necessary to assume an action exerted on the ether itself. In the electron theory of Lorentz which does not admit such actions on the ether, Newton's third law of motion is violated inasmuch as action and reaction take place neither at the same place nor at the same time.

These very brief and incomplete indications will perhaps suffice to call to mind some of the characteristic differences between the fundamental principles of ordinary mechanics and the modern electromagnetic theory. Is it necessary, then, to keep these two sciences distinct, or is it possible to build them up on a common foundation? Such a common foundation is certainly desirable; and it will ultimately amount to the same whether we try to generalize the principles of mechanics so as to embrace the electromagnetic theory, or whether we follow W. Wien* in deducing the principles of mechanics as a particular or rather limiting case from Maxwell's equations.

The question can be put in a somewhat different form. There seem to be two things underlying all the phenomena in the physical world, the ether and matter. To attain the unification of physical science, shall we consider the ether as a particular kind of matter? Or shall matter be interpreted electromagnetically? The older mechanics dealt exclusively with matter; and when it first became necessary to introduce the ether, this new medium was often endowed with properties very much like those of matter. The hydrodynamic analogy by which the apparent mass of the moving charge was interpreted above, illustrates this tendency. The physics of the ether has, however, reached so full a development that the properties of the ether are now known far more definitely than

*Ueber die Möglichkeit einer elektromagnetischen Begründung der Mechanik, *Archives néerlandaises* (2), 5 (Lorentz Festschrift), 1900, pp. 96–107.

those of matter. These properties are contained implicitly in the fundamental equations of Maxwell and Hertz which in their essential features are adopted in the electron theory of Lorentz.

In this theory the electromagnetic mass of the electron is nothing but the self-induction of the convection current produced by the moving electron. This mass depends on the velocity of the electron, or rather on the ratio of this velocity to that of light. Moreover, this mass, or inertia, may be of two kinds: longitudinal, as opposing acceleration in the direction of motion, and transverse, as opposing acceleration at right angles to the path. Any variation in the velocity is transmitted as a radiation through the ether with the velocity of light.

The electromagnetic energy does not reside in the moving electron, but is distributed through the whole field, with the volume density $(1/8\pi)$ $(\mathbf{E}^2 + \mathbf{H}^2)$, if $\mathbf{E}$ and $\mathbf{H}$ are the electric and magnetic vectors of the field. In determining the rate of work in any region we must take into account not only the time-rate of change of this energy in the region, but also the flux of energy through its boundary, which has the value $(c/4\pi)$ $\mathbf{E} \times \mathbf{H}$, per surface element, c being the velocity of light.

M. Abraham* has shown that the fundamental equations of Lorentz's theory of electromagnetism can be given a form that bears a striking resemblance to the fundamental equations of ordinary mechanics. But he has pointed out at the same time that in spite of this analogy of mathematical form, the real meaning of the equations is essentially different from their meaning in the older mechanics. The underlying invariant quantity is not ordinary mass, but the electric charge of the electron; mass, or inertia, is variable, depending on the velocity; momentum and energy are distributed through the field; the flux of energy, given by Poynting's radiation vector, is essential in determining the rate of working of a system. All these differences are ultimately due to the modern conception of the propagation of all actions, not instantaneously, but in time, through a medium. This idea, as seems to have been

* *Annalen der Physik*, Vol. 10 (1903), pp. 105–179.

foreseen long ago by Gauss* and Riemann†, requires a generalization of, or even a direct departure from, the ordinary laws of mechanics: the law of the relativity of motion, the conservation of linear and angular momentum and of energy in a closed system, the instantaneous equality of action and reaction.

It is now pretty generally recognized that Newton's "laws of motion," including his definition of "force," are not unalterable laws of thought, but merely arbitrary postulates assumed for the purpose of interpreting natural phenomena in the most simple and adequate manner. Unfortunately, nature is not very simple. "As the eye of the night-owl is to the light of the sun, so is our mind to the most common phenomena of nature," says Aristotle. And if since Newton's time we have made some progress in the knowledge of physics it is but reasonable to conclude that the postulates which appeared most simple and adequate two hundred years ago can not be regarded as such at the present time.

This does not mean, of course, that the mechanics of Newton has lost its value. The case is somewhat parallel to that of the postulates of geometry. Just as the abandonment of one or the other of the postulates of Euclidean geometry leads to a more general geometry which contains the old geometry as a particular, or limiting, case, so the abandonment or generalization of some of the postulates of the older mechanics must lead to a more general mechanics. The creation of such a generalized mechanics is a task for the immediate future. It is perhaps too early to say at present what form this non-Newtonian mechanics will ultimately assume. Generalization is always possible in a variety of ways. In the present case, the object should be to arrive at a mechanics, on the one hand sufficiently general for the electron theory, on the other such as to include the Newtonian mechanics as a special case.

After the searching criticism to which Poincaré, especially in

*Gauss, Werke, Vol. 5, p. 627. Compare *Encyklopädie der mathematischen Wissenschaften*, Vol. 12, pp. 45–46.

†Riemann, Werke, 2d edition, 1892, p. 288.

his St. Louis address*, in 1904, has subjected the foundations of mechanics and mathematical physics, almost the only one of the fundamental principles that appears to remain intact is the principle of least action. It seems, therefore, natural to take this principle as the starting point for a common foundation of mathematical physics and of a generalized mechanics, but with a broader definition of "action," or what amounts to the same, with a generalized conception of "mass" so as to make the latter a function of the velocity.

A very notable attempt has recently been made in this direction by E. and F. Cosserat†. And although only a first instalment of their investigation has so far been published, the able way in which the difficult problem is here attacked seems full of promise for a solution as complete as the nature of the case may warrant.

It may, perhaps, be said that, in demanding a generalization of the foundations of mechanics on such broad lines, I have attached undue importance to the electron theory as developed by Lorentz and Abraham, a theory which is still in the formative stage. There exist electromagnetic theories that appear less radical in their departures from the older views, and not so much open to the objection of violating long established principles. But if I have insisted particularly on the theory of Lorentz, it was just for the purpose of bringing out as clearly and forcibly as possible the differences between the old and the new.

Besides, there is one minor feature in the form of presentation adopted by Lorentz and Abraham which appeals to me as worthy of attention: it is the consistent use of the vector analysis of Gibbs and Heaviside. And perhaps this is really somewhat more than a mere matter of form. Burkhardt‡

*_Bulletin des sciences mathématiques_ (2), 28, pp. 302–324; English translation in the _Bulletin of the American Mathematical Society_, Vol. XIII, February 1906.

†_Comptes rendus_, Vol. 140, pp. 932–934; for a more detailed development see the notes contributed by E. and F. Cosserat to the French translation of O. D. Chwolson's "Traité de physique," Paris, Hermann, 1905.

‡_Mathematische Annalen_, Vol. 43 (1893), pp. 197–215.

has shown that this vector analysis has a rational mathematical basis. And after the numerous and manifold applications that have been made of this method its usefulness can no longer be questioned. The diversity of notations used by different authors can hardly be regarded as a serious objection. Have we not a large variety of notations even in so old and well-established a branch of mathematics as the differential calculus? The important thing about vector analysis is that it teaches to think in vectors and fields. E. Picard*, in a lecture, has recently called attention to the importance of the field even in ordinary elementary mechanics. A. Föppl has led the way in using vector symbols in an elementary treatise on technical mechanics.

Vector addition is now more or less familiar even to the student of the most elementary mechanics, largely owing to the influence of graphical statics. Is it not time to introduce at least the scalar and vector products and the time-differentiation of vectors in the mechanics of the particle and the rigid body? The gain in clearness and conciseness in stating the more general propositions is certainly great. In the mechanics of deformable bodies and media (hydrodynamics, elasticity), the general theory of vector fields, with the fundamental notions of divergence and curl, flux and flow, lamellar and solenoidal fields, etc., should surely form the preliminary mathematical basis for all further study; and here the simple symbolism of vector analysis is particularly well adapted to the subject.

But whatever may be the form of presentation selected, the study of the fields of scalars, vectors and higher point functions, so intimately connected with the modern views of physical phenomena, might well claim more attention on the part of the pure mathematician than it has so far received.

*"Quelques réflexions sur la mécanique, suivies d'une premiére leçon de dynamique," Paris, 1902.

REPORT OF THE SECRETARY OF SECTION A.

Dr. Edward Kasner, of Columbia University, was elected vice-president for the year 1907.

The address of the retiring vice-president, Professor Ziwet, on "The Relation of Mechanics to Physics," was presented on the afternoon of December 29, in the general assembly room in Gibson Hall, Tulane University. This address has already been published in SCIENCE for January 17 of the current year.

At the regular program meeting of the section, held on the morning of December 30, the following papers were presented:

On the groups of Order $p^{mn}q$ having Abelian Subgroups $H_{p^{mn}}$ of Type $(n, n, \cdots, n)$: O. F. GLENN, Drury College, Springfield, Mo.

This paper is supplementary to one presented by the author at the Philadelphia meeting of the association, in which the case $n=1$ was discussed. The defining relations of all groups described in the title are tabulated, and their properties discussed in relation to the properties of the Galois field $GF[p^{mn}]$ determined by the automorph of the subgroup H. It is found that all of the groups in question are members of a general family and have one general set of defining relations.

A New Straight in non-Euclidean Geometry: G. B. HALSTEAD, Kenyon College, Gambier, O.

The paper sets forth the discovery that, in Riemannean non-Euclidean geometry, the six mid-points of the parts of the six rays from the vertices of any triangle obtained by prolonging the sides, are co-straight. This is a new and noteworthy straight associated with every triangle.

The theorem is demonstrated, and then interpreted in ordinary Euclidean space.

A Chapter in the Present State of Development of the Elliptic Functions: HARRIS HANCOCK, University of Cincinnati, Cincinnati, O.

The paper is an attempt to show that practically all (American and European) writers on the elliptic functions have been giving too much emphasis to certain parts of Weierstrass's theory, while they have neglected many of the lines of thought which Weierstrass himself considered fundamental.

It is shown that the so-called Weierstrassean normal-form is not due to Weierstrass. The introduction of new functions gives a different

aspect to the presentation of the elliptic functions, although little that is new has been added thereby to the theory itself. Weierstrass's great work lies in a somewhat different direction; with him the problem of determining all analytical functions which have algebraic addition theorems is the leading idea.

The paper also brings into evidence several fundamental theorems of Hermite and shows some of the characteristics of Riemann's theory.

A Catalogue of 1,607 Zodiacal Stars for the Epochs 1900 and 1920, Reduced to an Absolute System: H. B HEDRICK, U. S. Naval Observatory, Washington, D. C.

This catalogue was prepared by the writer, in the Nautical Almanac Office, in order to fill the widely felt need of more fundamental positions of stars within the zodiac.

In its construction fifty-two observational catalogues were used. Systematic corrections were applied to each catalogue to reduce it to the same absolute system as that of the "Catalogue of Fundamental Stars," by Professor Simon Newcomb, published in the "Astronomical Papers of the American Ephemeris," Volume 8, Part 2.

Definitive positions were obtained by least square solutions of all the observations of each star. Right ascensions, declinations, variations and proper motions are given for two epochs, 1900 and 1920. Other features are the reference numbers to well-known catalogues, the Besselian star constants for 1910 for each star, and an index of stars by letter and constellation or by a special name.

This paper will be printed in the "Astronomical Papers of the American Ephemeris," Vol. VIII, Pt. 3.

A Class of Central Forces: EDWARD KASNER, Columbia University, New York City.

There exists no field of force in which a particle started from an arbitrary position with arbitrary velocity will describe a circular path. In the case of a central force the only possible circular trajectories are, in general, those whose centers are at the origin of force. If, however, the force varies according to a function of the form $br(r^2-a)^{-3}$, then a quadruple infinity of the trajectories are circular. In the simplest case, arising when a vanishes, the force varies inversely as the fifth power of the distance, and the circles all pass through the origin. In the general case they are orthogonal or diametral to a fixed sphere.

Solar Photographs: F. H. LOUD, Colorado College, Colorado Springs, Colo. Presented by title.

The Groups of Order p^m which contain exactly p Cyclic Subgroups of Order p^a: G. A. MILLER, Stanford University, Cal.

The main theorems proved in this paper may be stated as follows: If a group of order p^m, p being any odd prime, contains exactly p cyclic subgroups of order p^a, $a > 2$, it contains exactly p cyclic subgroups of every order which exceeds p and divides p^{m-1}. Hence it is one of the two non-cyclic groups of order p^m which contain operators of order p^{m-1}. When $a = 2$ and $p > 3$ the theorem is still true. In fact, the only possible exception occurs when $a = 2$, $p = 3$ and $m = 4$. In this special case there are three groups which contain exactly p cyclic subgroups of order p^a.

When $p = 2$ the preceding theorem is replaced by the following: If a group of order 2^m contains exactly two cyclic subgroups of order 2^a, $a > 2$ it can not contain more than two cyclic subgroups of any higher order. If a group of order 2^m contains exactly two cyclic subgroups of order 2^β but does not contain any cyclic subgroup of order $2^{\beta+1}$, then m can not exceed $2^{\beta+2}$. These theorems involve the fundamental properties of all possible groups whose order is a power of any prime p and which involve exactly p cyclic subgroups of any given order p^a. From a well known theorem it follows that a is not unity, but it can have every other possible value less than m.

Inversion and Inversors: J. J. QUINN, Warren, Pa.

In this paper are presented two new theorems relating to inversion, besides an explanation of the construction of certain linkages exhibiting the operation of inversion.

Observations of the Total Solar Eclipse of 1905, August 30, at Tripoli, Barbary: DAVID TODD, Amherst College, Amherst, Mass.

Observations were undertaken under six different heads, as follows:

1. Observations of the geometric contacts.

2. Coronal photography with a twelve-inch Clacey lens photographically corrected. Professor Todd's modified form of Burckhalter revolving occulter was employed. The corona was photographed to 30′. Baily's "beads" were also photographed before the second contact.

3. A duplex Clark lens of three inches was used for long exposures on the circumsolar stars and the outer coronal streamers. Neither these nor any intra-Mercurial planets were revealed, although 14 x 17 plates of the highest sensitiveness were used.

4. With a three-and-one-half-inch Goerz doublet of thirty-three and one-half inches focus, attached to one of the automatic movements used during the previous expeditions of 1896, 1900 and 1901, sixty-three

fine pictures of the corona were secured during the 186 seconds of totality. Some of these show the coronal streamers to exceptional length.

5. Sketches of the corona were made with the usual results.

6. Observations of the shadow bands were begun at least ten minutes prior to totality. The bands were wavering and narrow, moving faster than one could walk and at right angles to the wind, their length with it. They were observed to wax and wane five times during the interval of observation preceding totality. These observations have been communicated in detail to Mr. Lawrence Rotch, of Blue Hill, and embodied in his exhaustive study of this phenomenon.

Computed Traces and Totality-Durations of the Total Solar Eclipses of the Twentieth Century: DAVID TODD and R. H. BAKER, Amherst College, Amherst, Mass. Read by title.

A Possible Extension of the Theory of Envelopes: L. G. WELD, State University of Iowa, Iowa City, Ia.

(*a*) In the equation $f(x, y, \alpha) = 0$, representing a family of loci, by giving to α, first an increment and then a corresponding decrement, each of magnitude $\triangle\alpha$, solving the resulting equations for the coordinates of the point of intersection and, finally, letting $\triangle\alpha = 0$, there will be obtained

$$x' = \varphi(\alpha),\ y' = \varphi'(\alpha).$$

These equations define a point of the envelope of the given family of loci and eliminating α between them gives

$$F(x', y') = 0,$$

the equation of the envelope.

The point (x', y'), determined as above, may be called the tracing point of the locus, that is, the point which, for the moment, is tracing the envelope. It was shown in the paper, by way of illustration, that the tracing point for the envelope of the family of ellipses,

$$\frac{x^2}{\alpha^2} + \frac{y^2}{\beta^2} = 1,\ \alpha + \beta = c,$$

is the Fagnani point.

(*b*) The inverse of the above notion was next developed with reference to the right line, viz.: A point on the line

$$\frac{x}{\alpha} + \frac{y}{\beta} = 1,$$

being assigned at will, to find the functional relation between the intercepts,

$$\phi\ (a, \beta) = 0$$

(*i. e.*, the law governing the motion of the line), in order that the given point may trace an envelope and, finally, to obtain the equation of the envelope. The required relation is given by either of the differential equations,

$$x' = \varphi\ (a, \beta) = \frac{a^2}{a - \beta \dfrac{da}{d\beta}}, \quad y' = \psi(a, \beta) = \frac{\beta^2}{\beta - a \dfrac{d\beta}{da}}.$$

In general both equations will be needed in order to determine the constants of integration. Having thus obtained the function ϕ, which is, in effect, the tangential equation of the envelope, the equation in rectangular coordinates readily follows.

Several examples applying the principles were presented and its application to other families of loci was suggested as a promising field of investigation for the amateur mathematician.

LAENAS GIFFORD WELD,
Secretary

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PHYSICS.

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ADDRESS

BY

WM. F. MAGIE,

VICE-PRESIDENT AND CHAIRMAN OF SECTION B FOR 1905.

THE PARTITION OF ENERGY.

As I rise in this place to address you, I recall a dear friend who stood before you in a similar position three years ago, and whose premature death has dealt so severe a blow to this association and to the science represented in this section. The name of DeWitt Bristol Brace will always be honorably remembered in the history of physics. While a student at Boston University, he began the study of that science, and after his graduation in 1881, he proceeded to Johns Hopkins University to devote himself exclusively to it. After two years of study there, he went to Berlin, where he heard the lectures of Kirchhoff, and worked in the physical laboratory under the direction of Helmholtz. It was in Berlin that he definitely settled the whole course of his subsequent scientific career, by insisting on taking up, as his subject of research, the difficult question of the exact mode of transmission of a polarized ray which is undergoing magnetic rotation. This question was out of the line along which the work of the director and of his students was proceeding at that time, and Brace not only set the problem for himself, but owed entirely to his own inventive genius the brilliant method which he proposed for its solution. I remember how difficult it was for Brace to convince our director of the possibility of transmitting the ordinary and extraordinary beams in a common direction in a crystal of Iceland spar; and the doubts of the director of the realization of the demonstrated conditions, even if they could be proved pos-

sible in theory. After Brace had succeeded in experimentally obtaining the conditions which his theory called for, he applied them to the examination of the question of the transmission of a polarized ray in a magnetic field. He was not able at that time to answer the question which he had in mind, but he was able to produce a memoir full of discoveries and ingenious suggestions, which culminated many years afterward in his final resolution of the problem, by the actual separation of the plane polarized ray in a magnetic field into two circularly polarized components.

Brace took his doctor's degree in 1885. After a short service at the University of Michigan, he became, in 1888, professor of physics at the University of Nebraska, where he devoted himself with the conscientious fidelity which was a part of his nature, to the duties of his position. These duties he did not interpret in any narrow sense. He conceived that it was a large part of the obligation, which lay on him, to promote the progress of physics, not only by his own researches, but by organizing and assisting a corps of fellow-workers. By his enthusiastic zeal, and by the wise administration of the facilities afforded him, he was able to draw around him a number of men who caught inspiration from his spirit, and who have, by their published researches, for several years past, been giving to the institution in which they worked an honorable prominence.

In the midst of his official duties Brace gave what time and strength he could spare to his own investigations. His mind was exceedingly fertile in the invention of methods of observation. The subject of optics, in which his first original work had been done, remained the subject of his choice throughout his life. As that science has developed in connection with certain theories of electricity, fundamental questions have arisen, principally relating to the general subject of the relative motion of matter and the ether, which can only be answered by carrying observation to a degree of refinement which was not attained in the classical experiments of the great French and English investigators. Brace was profoundly interested in this great subject, and his principal task, for several years, was to improve the methods of observation to such a degree that indub-

itable conclusions might be drawn in regard to the results of experiments left doubtful by earlier investigators. By the union of inventive power with great experimental skill he succeeded in extending the range of observation in his repetitions of the experiment of Lord Rayleigh, to test for possible double refraction in an isotropic medium; the experiment of Mascart, to test for a differential effect on the natural rotation of the plane of polarization; and the experiment of Fizeau, to test for a possible change in the azimuth of the plane of polarization of a ray, polarized by refraction, to so high a degree of accuracy as to be able to confirm with confidence the negative results of Rayleigh and Mascart, and to assert with equal confidence that the positive result, which Fizeau believed he had obtained, must have been due to some experimental error and not to the cause to which it is sometimes ascribed. He had in mind other experiments to test the same general question, and we who knew the rare combination of powers which he possessed did not even despair of his succeeding in making the final test which is necessary, by the determination of the velocity of light when transmitted in one direction only.

This is not the place to enumerate Brace's contributions to science. It is sufficient to notice that part of his work in which his activity culminated, and which was most closely connected with his hopes for the future. All his other work showed the same distinguished qualities; unusual ability of invention, great experimental skill. and the faculty of choosing central subjects to which to devote his powers.

Brace was for several years a member of this association, and was vice-president and chairman of Section B for the year 1901-2. He was also a member and vice-president of the Physical Society, and considering the distance between his home and the usual place of meeting of that society, a frequent attendant at its meetings. He very greatly enjoyed the opportunities afforded by them to meet with his friends. Under a somewhat retiring manner he concealed a warm heart and a sincere and unselfish admiration of other men's abilities and successes. His encouragement and sympathy were always given to those who came to him to talk about their scientific projects; and it renews my own sense of bereavement when I recall the cordial

way in which he discussed with me the subject of the present address. His life of untiring devotion to duty and of genuine goodness will always remain a sweet memory to his friends, as his lofty and unselfish zeal for the promotion of knowledge will be an example and a stimulus to those who know the story of his work.

In the retrospect of the progress of physics during the past year, the attention is first and most forcibly attracted to the work which has been done in the general subject of radioactivity. By the continued labors of J. J. Thomson and of those in his immediate circle of fellow-workers, of Rutherford and Bragg, of Lenard and Kauffmann, and of many others, our knowledge of the details of the radioactive process has been very much extended. Some progress, though not so great, has been made in the development of the theory. But the main result, which, it seems to me, can be considered as attained during the year, is the final appreciation of what we may call the electrical theory of matter, or at least of the possibility of explaining the properties of matter, even those of the most fundamental character, by the laws of electric action. Of course such an explanation can not yet be given, but it seems to me that, so far as we can judge by the hints and the *obiter dicta* which appear from time to time, the belief in the ultimate possibility of such an explanation has at last become general.

I doubt if the history of science affords another instance of so fundamental a revolution in modes of thinking, occurring in so short a time. For it is only ten years ago that Röntgen discovered the peculiar radiation that is known by his name, and I think we may fairly date the beginning of the study of radioactivity from that important discovery. On the one hand, the facility which with gases can be ionized by the Röntgen rays aided J. J. Thomson materially in his study of ionization which led to his discovery of the electron and his investigation of its properties. On the other hand, the fluorescent effects of the Röntgen rays incited Becquerel to his examination of uranium, and led to his discovery of its radioactive properties; and from this to the isolation of radium by M. and Mme. Curie, and to the splendid series of researches which have been carried out on that substance and on other allied substances, the way

is clear. Röntgen's discovery was made only ten years ago, and it is a marvelous illustration of the large sum of human effort applied to the study of science, and of the active, I might almost say the radical, tendency of the modern mind, that in so short a time we have obtained so great a body of established knowledge, and experienced so complete a revolution in our most fundamental modes of scientific thought.

In the domain of optics, also, there has been considerable progress, of which a very important part is due to our lamented friend, whose work I have already considered. In other parts of our science, the work which has been done is not of so consecutive a character, nor has it been productive of such important results as to call for particular mention.

The subject upon which I wish to speak to you to-day is that of the partition of energy. As is well understood, the energy here referred to is the kinetic energy of the moving particles, which, according to the kinetic theory of matter, constitute a body. The general theorem which I wish to discuss may be stated by saying that the kinetic energy of the body is so distributed among the degrees of freedom, by which the state of the body as a dynamical system is described, that an equal share is, on the average, allotted to each degree of freedom of each type of molecule.

Since the enunciation of this theorem as applied to gases, by Maxwell, in 1859, it has from time to time attracted the attention of the mathematical physicists. Lately it has again been brought forward, and the difficulties which surround it very considerably removed, by the work of Jeans. This author has collected the results of his own researches, in combination with a historical and critical study of previous work on the question, in a recently published book, which covers the ground so completely as to supersede any independent study of the subject which I could have made; but I trust that the exposition of it which I shall give will be of interest as an introduction to the experimental matter which I shall adduce; and that this will at least indicate a way in which we may hope to obtain some confirmation of the theorem of equipartition.

The questions which have always been raised about this im-

portant theorem of the kinetic theory at once come to our minds. First, is the theorem true, or rather, does it state what would be true for an ideal system of particles moving freely within a containing vessel? second, is the proof of the theorem impeccable? third, is there any experimental evidence that it applies to real bodies?

I would remark about the first question that the theorem is so distinguished by its simplicity, and by its aspect as a sort of unifying principle in nature, that few men can set it fairly before their minds without at least desiring to believe it true. Most of those who have recognized that Maxwell's original demonstration was not flawless are still convinced of the truth of his conclusion, or at least believe his conclusion to be so probable as to make it worth while to try for a more accurate demonstration. Their state of mind is like that of Clausius and of Lord Kelvin, when they perceived that Carnot's theorem respecting the efficiency of a reversible engine could not be proved in the way in which Carnot tried to prove it.

With respect to the second question, it was very soon pointed out that Maxwell had made in his proof an assumption that could not be justified by immediate inspection, and which was itself in need of demonstration or of avoidance. The later demonstrations of Maxwell and Boltzmann have been likewise subjected to criticism, and can be shown to involve assumptions that will not be granted on inspection. The difficulties that arise in these proofs come from the necessity of applying in them the calculus of probabilities, and center around the question of the legitimacy of the application of that calculus. It is commonly agreed that Maxwell and Boltzmann have assumed a condition of the system of moving particles, as a requisite for the application of the calculus of probabilities, which is contradicted by many systems of which we have certain knowledge, and can not without proof be admitted as likely to obtain in other systems, about which less is known. In the method employed by Jeans, the application of the calculus of probabilities is made in a different manner, and does not necessitate the introduction of the hypothesis of Maxwell and Boltzmann. It seems to me that, in this last form of the theory, the dif-

ficulties which have environed the subject have at last been mastered.

In respect to the third question, that concerning the experimental evidence for the truth of the theorem, it is well known that, in general, Boyle's law follows as a consequence of the general principles of the kinetic theory; that Gay-Lussac's law is an immediate consequence of a relation plausibly assumed between temperature and the kinetic energy of the molecule; that the motion of the radiometer and the laws of transpiration and many other properties of gases can be deduced from the general theory; and, in particular, that Avogadro's law follows from the simplest form of the theorem of equipartition. But further proof of this theorem in its general form is still needed. Such proof as we have will be discussed later in this address.

Let us consider a little more fully the proofs of the theorem of equipartition. It was first enunciated in 1845, in a paper presented by Waterston to the Royal Society, but this paper was not published at that time, and Maxwell's paper of 1859 first brought the theorem to the attention of the scientific world. In that paper Maxwell undertook to prove that when two systems of molecules move in the same vessel the mean *vis viva* of each particle will become the same in the two systems.

The proof of this proposition by Maxwell is the one still commonly employed in elementary expositions of the kinetic theory of gases. As applied first to a single gas, he considers the molecules or particles of the gas as elastic spheres, and represents the average number of particles which have a velocity in one direction lying between two very near limits as a function of that velocity. To represent the average number of particles which have a velocity in either of the other two rectangular directions lying between certain near limits, he uses the same function, and he then supposes that the three velocities thus used are independent of each other, so that the average number of particles which possess all three velocities at once will be given by the product of three independent probabilities. Since this number depends only on the relative motions of the particles, and not on the particular directions in which the coordinate axes have been drawn, it may also be represented by a function of the resultant velocity of the particles, or by a function of the sum of the squares of the component velocities.

Equating these two expressions, a functional equation is obtained, the solution of which leads to the well-known exponential law of the distribution of velocities among the molecules.

By extending the method just described to the consideration of the relative motion of the particles of two gases, Maxwell proceeded to show that the probable number of particles, whose velocities differ by a certain amount, is expressed by the same exponential function as that already obtained; and he shows further that the probable mean relative velocity is the square root of the sum of the squares of the mean velocities in the two systems.

On the basis of this proposition, Maxwell proves that the average kinetic energy of the molecules of two or more gases, when they are mixed, will be the same for each. To do this he shows simply that the difference of the mean kinetic energies of the molecules of two gases will be diminished by collision, so that it is only necessary that a sufficient number of collisions take place to reduce this difference to zero.

The defect of this demonstration lies in the assumption that the velocities in the three rectangular directions can be considered as independent. As they do not enter independently in the equations of collision between the molecules, we might fairly expect them to be related to each other, until they are proved to be independent.

I have dwelt on this first method of Maxwell's, because of its historic importance, and because it illustrates the difficulty of deciding by inspection on the conditions which may legitimately be assumed for the application of the calculus of probabilities. In the elaborate method subsequently developed by Maxwell and by Boltzmann, the same difficulty is met with in another form. In this method the molecules are considered as spheres, freely moving about within a vessel and colliding with each other. The effort is made to determine the characteristics of the motion of the assemblage of molecules which must obtain if the condition of the assemblage is to be, to outside inspection, uniform. To do this, we consider a number of molecules belonging to a certain class characterized by possessing certain component velocities before collision, and certain other component velocities after collision, and a number of molecules be-

longing to another class characterized by possessing the same component velocities in the reverse order, and, considering the probable number in each of these classes as a function of the component velocities, we write down the expression for the probable number of molecules of these two classes which occupy the same element of volume and so are in collision. With this expression we can obtain an expression for the average increase in the number of molecules in one of the classes, due to collisions and this ought to be zero if the condition of the assemblage is to be uniform. From the discussion of this last expression follow Boltzmann's H-theorem, the formula for distribution and the theorem of equipartition.

When the mode is analyzed in which the expressions giving the probable numbers of molecules in the two classes are combined, it appears that an assumption is involved in it which is not evident on inspection; namely, that the probability of the presence of a molecule of one class in an element of volume is independent of the coordinates of that element, or, what amounts to the same thing, of the probability of the presence, in the same element of volume, of a molecule of the other class. The gas to which this assumption applies is called by Boltzmann unordered with respect to the distribution of the molecules (*molekular-ungeordnet*). Jeans uses for this condition of a gas the very convenient phrase "molecular chaos."

Now we evidently can not assert off-hand that this chaotic condition will obtain in all systems of particles which represent real gases. When Boltzmann tries to define it he does so by negative instances, showing what the condition of the system might be which would be "ordered" with respect to the distribution of the molecules; and then leaves us to infer that the vast majority of distributions do not possess any peculiarities which would put them in the "ordered" class. But this inference is not readily drawn. It is evident that any condition of the system is "ordered," in the sense that the successive conditions follow on mechanical principles from the initial condition. All that we can do by inspection is to cherish the hope that, while all systems are "ordered" in this sense, yet a vast number of them—an infinite number of them, it may be, in comparison with those "ordered" in Boltzmann's sense—are still "unordered"

in such a sense that the application of the calculus of probabilities to them, as made by Maxwell, may not lead to an erroneous result. To assert that this is so requires proof.

An alternative method of dealing with the theory of gases, of which the latest development is due to Jeans, proceeds by treating a gas as a single dynamical system, specified by the positional coordinates and the component velocities of its molecules. We then, to use Jeans's words, consider "an infinite number of systems, starting from every conceivable configuration, and moving over every path; and investigate, as far as possible, the motion of this series of systems, in the hope of finding features common to all." Jeans carries out this investigation by representing each particular phase of the system by a point in a generalized space. The successive phases through which one of the systems will pass will be represented by the points along a line in the generalized space. Jeans shows that these lines will be "stream lines" in the space; and that to investigate the infinite number of systems already supposed, comes to the same thing as to suppose the generalized space filled with a fluid, moving along stream lines determined by the dynamical equations of the gas, and to investigate the motion of this fluid. This motion is found to be a "steady motion." The advantage of this mode of procedure is that the applications of the calculus of probabilities are made to the elements of the generalized space, and are obviously legitimate.

By an argument based on this fundamental mode of representation Jeans shows that all but a negligibly small fraction of the generalized space represents systems in which the density of the gas is uniform; and that within that part of the generalized space which represents states of the system in which the energy is constant, all but an infinitely small fraction represents systems in which the velocities are distributed according to Maxwell's exponential law. Such a state of the system Jeans calls the "normal state," and his conclusion is that it is infinitely probable that a gas in ordinary circumstances will be in the normal state.

We may consider this result as an *a posteriori* proof of the hypothesis of molecular chaos.

By a treatment that is essentially similar, and without using the hypothesis of molecular chaos, it follows that it is infinitely probable that the energy of the gas is, on the average, distributed equally among the degrees of freedom corresponding to molecules of different types, and also among the degrees of freedom of each type considered independently.

When Maxwell attempted to prove the law of equipartition for the time averages of the energy associated with the different degrees of freedom of a single system, he introduced the hypothesis that the system goes through all possible phases, consistent with the conservation of energy, before returning to its initial phase. It is difficult to see how this can be the case in a system self-contained and entirely subject to the laws of dynamics, such as, for example, a gas within the smooth envelope ordinarily postulated in the theory. But if we think of the envelope as itself an assemblage of moving molecules, it may be that the courses of the gas molecules will be changed so irregularly by impacts at the boundaries, that the gas may be thought of as experiencing so many fortuitous disturbances that it will practically fulfil the condition of passing through all possible phases. In this case the law of equipartition can be extended to the time average of any one degree of freedom.

Lord Kelvin has taken exception to this form of the theorem of equipartition, asserting that the proof is invalid, and that it is not true in fact. To demonstrate the latter statement, in default of any direct experimental method, he has resorted to the calculation of the paths and velocities of a moving body within an envelope of some assumed form, and a comparison of the kinetic energies associated with each degree of freedom. To introduce the element of chance, the courses of the body were mapped out by the help of numbers obtained by drawing numbered cards from a pack. The results obtained differed considerably from the exact equalities deduced from the Maxwell-Boltzmann theorem. I do not pretend to be able to show that these results of Lord Kelvin are of no value as evidence against the truth of the theorem, but I would remark that we can at least justify a doubt about them by noticing how small a deviation in the experiments from perfect im-

partiality of conditions will suffice to produce a large deviation from the expectation of the theory of probabilities. To test this, and remembering that when I used to play whist we noticed that a black card turned up as trump oftener than a red one, I procured a new pack of cards, which ought to be impartial and unbiased, if anything is, and cut it a number of times, noting the suit of the card exposed by the cut. In 312 cuts the black suits were recorded 196 times, the red suits 116 times. Spades were recorded 111 times, clubs 85 times, diamonds 68 times, hearts 48 times. Practically the same ratio (184–121) between the black and red suits was obtained with an old pack, though the order of suits was different. Such a persistent departure from the expectation of an equal number of each color and of each suit indicates that for some reason the cards are not impartial, and a scrutiny of a new pack shows, I think, the reason for this. When the pack is examined, the bottom card is usually the ace of spades, and then the spade suit follows in order. The uppermost suit is generally the hearts. I believe that, when the pack is trimmed, the knife is pressed out as it goes down, so that the upper cards are cut a little smaller than the lower ones. The difference in size can be seen if the pack is evened up on a smooth surface. Some cards will then appear a little wider than the others, and if they are picked out, they will generally be found to be black cards. Now I do not know how Lord Kelvin's pack of cards was made, or how the cards were drawn, but I think we may fairly suppose that the discrepancies of 15 per cent. or so, which appeared in his experiments, may have been due, not to a failure of the theorem of equipartition, but to trifling departures from impartiality in his method of experimentation.

We are now ready for the examination of the experimental evidence for the applicability of the theorem of equipartition to real bodies. The most important evidence that bears on the question is found in the observed values of the specific heats of gases, and of the ratios of their specific heats of constant pressure and of constant volume. If we consider the distribution of the energy which enters a gas at constant volume when its temperature rises one degree, designating its specific heat of

constant volume by C_v, the increase in the energy of translation of the molecules by C_o, and the ratio of the two specific heats by γ, it is easy to show that

$$\gamma - 1 = \frac{2}{3}\frac{C_0}{C_v}.$$

Now if each degree of freedom acquires an equal share of kinetic energy, say k, the energy of translation increases by $3k$ so that

$$\gamma - 1 = \frac{2k}{C_v}.$$

Furthermore, C_v will equal k times the total number, n, of degrees of freedom of the molecule, added to an unknown amount, P, of potential energy. We thus get

$$\gamma = \frac{2k}{nk + P} + 1.$$

If we assume that the molecules of the gas do not take up potential energy, so that $P=O$, and then assume that the molecules are practically points, so that $n = 3$, corresponding to the three translational degrees of freedom, we have $\gamma = 5/3$. This is the number found for this ratio in certain cases, in one of which at least, that of mercury vapor, we have independent reasons to believe that the molecule is monatomic. If we set $n = 5$, as would be the case if the molecules were solids of revolution, we get $\gamma = 7/5$, which is the value found for several diatomic gases. If $n = 6$, as would be the case if the molecules were irregular solids, we get $\gamma = 4/3$, a number not often found as the value of the ratio, the numbers obtained for gases not belonging to the other two classes being generally less than this. So far we seem to have an imperfect agreement with the theory, but the conditions assumed are evidently not those of real molecules. Staigmüller has shown a way, to which I shall direct particular attention, to modify the formula so that it can be applied to real gases; but before doing so, I wish to consider the general question, which will not be settled by our

being able to find that certain assumed values of n will give observed values of γ. Have we a right to believe that the number of degrees of freedom of a molecule, other than the three degrees of translational freedom, are ever, in any case, so few as we must suppose to get the results referred to? Are we not rather bound to believe, from the evidence of internal vibration afforded us by the spectroscope, that the molecules or the atoms of all gases are vibrating in many modes, or are compound bodies whose parts are executing vibrations? And should we not therefore set our number n of degrees of freedom very large, and so obtain a value of γ practically equal to unity for all gases, in entire disagreement with the experimental results? The view of the constitution of the atom which prevails at present, that it consists, at least in part, of an assemblage of electrons having the essential properties of mass and moving in orbits with enormous velocities, supports the evidence of the spectroscope, and makes it all the more necessary for us to admit that the molecule of gas will have a great number of degrees of freedom.

A reconciliation of these views with a modified doctrine of equipartition has been made by Jeans. The proofs of the theorem of equipartition apply to a conservative system, and fail as soon as they are applied to a system in which the energy is not constant. Now we know that, as a matter of fact, every material system is transferring energy to the ether—indeed, as Jeans remarks, our seeing it at all depends upon that operation—and it appears therefore that we ought not to expect the theorem of equipartition to apply to real systems without further examination. To carry on this examination we conceive of a system so constituted that the energy which corresponds to certain of its degrees of freedom can and does pass rapidly into the ether, while that corresponding to the remaining degrees of freedom is dissipated by transfer to the degrees of freedom of the first class. On this supposition Jeans shows that the energy resident in the system may be divided among the degrees of freedom according to a modified mode of equipartition; those coordinates whose energy is not transferred directly to the ether possessing equal amounts of energy, corre-

sponding to the temperature of the body indicated by the thermometer and to the formula $mv^2 = 3RT$, while those coordinates whose energy is directly dissipated into the ether also possess equal amounts of energy, different from the other amounts, and corresponding to another function t, whose dimensions are those of temperature, and which conforms to a formula similar to the one just given, with the same constant R. The two temperatures thus introduced Jeans calls the principal and subsidiary temperatures and the degrees of freedom to which they correspond, the principal and vibratory degrees of freedom. He shows that, provided the product of the time occupied by a collision between two molecules and the frequency of the atomic vibration is large, the transfer of energy from the principal to the vibratory degrees of freedom goes on very slowly; and he shows further that we may believe that the postulate here made applies to real bodies, so that, when a gas is heated, we may consider that practically all the energy which it receives is taken up by the principal degrees of freedom. If this be granted, we may ignore, for practical purposes, the multitudinous vibratory degrees of freedom, and are brought back to the simpler view of the constitution of the molecule as a collection of atomic masses bound together into a system. We have thus set before us the task of making plausible estimates of the number of principal degrees of freedom in the various gases, and of calculating the specific heats of these gases and the values of the ratio of their two specific heats. In doing this we shall follow the procedure of Staigmüller.

In the formula

$$\gamma = \frac{2k}{nk + P} + 1$$

the denominator $nk + P$ represents the energy received by the molecule, when its temperature rises one degree. We assume that the potential energy P is entirely that due to the displacements of the atoms in the molecule, and that the motions of those atoms are simple harmonic, so that the mean potential energy corresponding to each internal degree of freedom is equal to the mean kinetic energy. Using a to represent the

number of degrees of freedom of the molecule as a whole, and i to represent the number of internal degrees of freedom, we have

$$n = a + i,\ P = ik, \text{ and } \gamma = \frac{2}{a + 2i} + 1.$$

When we use θ to represent the sum $a + 2i$, the formula takes the simple form

$$\gamma = \frac{\theta + 2}{\theta}.$$

Our task is to estimate the values of a and i in particular cases, and to calculate therefrom the values of γ.

Before proceeding to do this we will calculate the expression for the specific heat of constant volume in terms of the degrees of freedom. Denoting again by k the energy corresponding to one degree of freedom, which a gram-molecule of the gas receives when its temperature is raised one degree, and by m the molecular weight, we may write $C_v m = k\theta$, and may calculate k as follows:

We know from Joule's calculation, that the velocity of mean square for hydrogen is 1.842×10^5 centimeters per second. From this we get the total mean kinetic energy of translation of a gram-molecule of hydrogen, one-third of which is the amount of kinetic energy apportioned to one degree of freedom. We then get the change in the energy apportioned to one degree of freedom, which occurs when the temperature rises one degree, by dividing by the absolute temperature 273, and reducing the result to gram-degrees, obtain for k the value $k = 0.9886$. This value is so nearly equal to 1 that for many of our subsequent calculations k will be taken equal to 1.

We are now in position to calculate not only the values of γ for various gases, but also their molecular heats, that is, the heat capacities of their gram-molecules, from estimates made of the probable number of their principal degrees of freedom.

In the case of a monatomic gas we suppose the molecules to act either as points or as smooth spheres, for which the only

effective degrees of freedom are the three translational ones. For these, therefore, we have

$$\nu = 3, \quad C_p m = 4.943, \quad \gamma = \tfrac{5}{3} = 1.66+.$$

I do not know that the molecular heats of the monatomic gases have been measured, but the values of γ obtained for mercury vapor, krypton, helium and argon, range from 1.666 to 1.64.

For the diatomic gases, while we still treat the atoms as points or smooth spheres, we notice that 5 coordinates are necessary, being also sufficient, to determine the position and orientation of the molecule, in view of the fact that its orientation about the line joining the two atoms is indifferent. The only other principal degree of freedom which the molecule can possess is the single one which determines the distance between the atoms. If this distance is fixed, we have $i = 0$, and $\theta = 5$; if it is variable, $i = 1$, and $\theta = 7$. From these assumptions we can calculate the constants for comparison with the results of observation.

$$\nu = 5. \quad \kappa(\nu+2) = 6.9202. \quad (\nu+2)/\nu = 1.400.$$

		$C_p m$	γ
Hydrogen	H_2	6.809	1.402
Nitrogen	N_2	6.830	1.405
Oxygen	O_2	6.960	1.402
Nitrous oxide	NO	6.951	—
Hydrogen bromide	HBr	6.642	1.400

$$\nu = 7. \quad \kappa(\nu+2) = 8.8974. \quad (\nu+2)/\nu = 1.286.$$

Chlorine	Cl_2	8.811	1.33
Bromine	Br_2	8.88	1.293
Iodine	I_2	8.50	1.294

When we consider the triatomic molecules, we find several of them of the type of which the molecule of water vapor is an example, in which we may suppose that the bivalent atom

stands between the other two similar atoms, at the center of gravity of the molecule. If we can conceive the atoms thus placed, we may consider the energy of the molecule as determined by the 5 degrees of freedom which fix the position and orientation of the molecule, and by one additional degree of freedom, determining the distance between either of the univalent atoms and the center of gravity. On these assumptions we obtain $\theta=7$.

$$\nu=7. \quad \kappa(\nu+2)=8.8974. \quad (\nu+2)/\nu=1.286.$$

		$C_p m$	γ
Water vapor	H_2O	8.649	1.29
Carbon dioxide	CO_2	8.91	1.285
Hydrogen sulphide	H_2S	8.33	1.276

For reasons which I will no tstop to give, Staigmüller considers the molecule of bisulphide of carbon to be of a different class, in which the above described symmetry does not obtain, so that we have $a=6$, and each of the sulphur atoms determined as to its distance from the center by one coordinate, so that $i=2$, and $\theta=10$.

$$\nu=10. \quad \kappa(\nu+2)=11.863. \quad (\nu+2)/\nu=1.200.$$

		$C_p m$	γ
Carbon bisulphide	CS_2	12.12	1.197

For the two vapors, phosphorous chloride and arsenious chloride, we may think of the univalent atoms as free to move in planes at right angles to the directions of the valencies of the trivalent atom, each with 2 degrees of freedom, while 6 more are needed to determine the position and orientation of the molecule. We have thus, in these cases, $\theta=18$.

$\vartheta = 18.$ $\kappa(\vartheta+2) = 19.77.$ $(\vartheta+2)/\vartheta = 1.111.$

		$C_p m$	γ
Phosphorous chloride	PCl_3	18.49	—
Arsenious chloride	$AsCl_3$	20.32	—

For the vapors silicon tetrachloride, titanium tetrachloride, and tin tetrachloride, we make the same assumptions as in the last case about the freedom of the chlorine atoms, and get $\theta = 22$.

$\vartheta = 22.$ $\kappa(\vartheta+2) = 23.726.$ $(\vartheta+2)/\vartheta = 1.091.$

		$C_p m$	γ
Silicon tetrachloride	$SiCl_4$	22.47	—
Titanium tetrachloride	$TiCl_4$	24.77	—
Tin tetrachloride	$SnCl_4$	24.41	—

There is a difficulty which I can not solve about the methane derivatives. Their specific heats have been determined only in two cases, but we have two sets of values of γ, one obtained by Müller, the other by Capstick. Müller's values conform fairly well to the hypothesis that the hydrogen atoms of the methane (CH_4) molecule are fixed, and that each chlorine atom substituted for a hydrogen atom introduces 2 interior coordinates.

	ϑ	$(\vartheta+2)/\vartheta$	γ
CH_4	6	1.333	1.32
CH_3Cl	10	1.200	1.20
CH_2Cl_2	14	1.142	1.12
$CH\,Cl_3$	18	1.111	1.11

The agreement is very good. On the other hand, Capsticks' numbers for γ are different, and generally larger than Müller's. They do not fit easily into any similar scheme.

The constant $k=0.9886$ may be used to calculate the atomic heats of the solid elements. To do this we make the hypothesis that the aggregation in these solids is atomic rather than molecular, and that each atom vibrates in simple harmonic motion about a position of equilibrium. On this assumption each atom will receive, when heated, twice the energy that is taken up by its three translational degrees of freedom. On the principle of equipartition, the energy taken up by one such degree of freedom is the same as that taken up by one translational degree of freedom of the hydrogen molecule, or is equal to the constant k. The atomic heat should therefore equal $6k$, or 5.93. A comparison of this with the observed values of the atomic heats, which range from 5.5 to 6.3, indicates that the hypothesis upon which the result is obtained is in the main correct. It is useless to speculate on the reasons for the different values of the atomic heats of the different elements. We can account for them without denying the doctrine of equipartition by supposing that the vibrations of the atoms are not strictly simple harmonic.

Hitherto we have followed Staigmüller. It seems to me clear, after studying his results, that it is possible to account for the specific heats of gases by supposing the energy distributed equally over certain degrees of freedom; and it seems to me, further, that the explanations which Staigmüller has given of his choices of the number of degrees of freedom which he selects for each type of molecule are at least plausible. The most striking feature of these choices is the small number of internal degrees of freedom assigned to the atoms. It seems as if the atoms were—at least with respect to certain directions of displacement—rigidly bound together. Lord Rayleigh has remarked that, on the ordinary theory of equipartition, no matter how small the play of an atom may be in the sense of a coordinate, the degree of freedom thus indicated must have its full share of energy, so that nothing short of a truly rigid connection in one direction will allow us to neglect the degree of freedom in

that direction. From this difficulty we may escape by the use of the distinction between principal and vibratory degrees of freedom. We may suppose that the forces between the atoms of a molecule vary with exceeding rapidity for relative motions in certain directions, while they do not vary nearly so rapidly for motions in other directions. If this is so, the period of the vibration due to the rapidly varying force will be very small, and the vibration will be of the type which communicates energy rapidly to the ether, so that motion in that sense will correspond to a vibratory degree of freedom. The other motions, of longer period, will correspond to principal degrees of freedom, and will alone be operative in taking up energy when the gas is heated.

It does not seem possible to extend Staigmüller's method directly to other more complicated molecules, for which it would be impossible to assume the atomic arrangement. But if we accept it as verified by its success in describing the specific heats of gases, we may use it to calculate the degrees of freedom in more complicated molecules from their known specific heats, and can then see if the numbers thus obtained appear to have any relation to the numbers and kinds of atoms in the molecules.

To exemplify this mode of procedure let us take the case of methyl alcohol. Its molecular formula is CH_4O; its molecular weight is 32; its specific heat between 5° and 10° is given by Regnault as 0.59; its molecular heat is therefore 19. If we may neglect the potential energy of the molecules with respect to each other in comparison with their kinetic energies, this molecular heat is distributed among 6 degrees of freedom of the molecule and the unknown number of internal degrees of freedom which is to be determined. From Staigmüller's formula, $C_v m = k(a + 2i)$, we get for i, $6.5 +$. Of course this is an impossible value for i, which should be integral, but the specific heat of Regnault's specimen of methyl alcohol is almost certainly too high, on account of the presence of water. We may take 6 as the most probable integral value for i. We might speculate about the possible assignment of these degrees of freedom to the different parts of the molecule of methyl alcohol according to its structural formula, but such a procedure would

be too arbitrary to carry conviction. What is immediately noticeable is that the number of degrees of freedom thus obtained is equal to the number of atoms in the molecule; so that if we assign one degree of freedom to each atom we can reproduce the molecular heat of methyl alcohol. This would be nothing more than a coincidence if it were not the case that the same relation holds for the other alcohols, whose specific heats are given in Landolt and Börnstein's tables for about 0°.

		No. of Atoms.	i
Methyl alcohol	CH_4O	6	6.5
Ethyl alcohol	C_2H_6O	9	9.5
Propyl alcohol	C_3H_8O	12	12.5
Isobutyl alcohol	$C_4H_{10}O$	15	15
Isoamyl alcohol	$C_5H_{12}O$	18	19

The general tendency of the values of i is to run above the sum of the atoms. This may be taken account of by a special assumption, as, for example, by assigning two degrees of freedom to the hydrogen atom in the hydroxyl group; but it is very likely that the specific heats given in the tables are too high, on account of the difficulty of freeing the alcohols entirely from water. The same general rule holds for many other organic compounds.

		No. of Atoms.	i
Ethyl ether	$C_4H_{10}O$	15	15.5
Benzol	C_6H_6	12	10.7
Oil of turpentine	$C_{10}H_{16}$	26	25
Hexan	C_6H_{14}	20	18.5
Heptan	C_7H_{16}	23	21.5
Octan	C_8H_{18}	26	26
Decan	$C_{10}H_{22}$	32	33
Dodecan	$C_{12}H_{26}$	38	40
Tetradecan	$C_{14}H_{30}$	44	46.5
Hexadecan	$C_{16}H_{34}$	50	53
Toluol	C_7H_8	15	13.5

In the case of several of the organic liquids, the calculated degrees of freedom can be reproduced by assigning 2, or sometimes 3, degrees of freedom to the hydrogen atoms.

		i Estimated.	i Calculated.
Isoamyline	C_5H_{10}	25	24.5
Acetic acid	$C_2H_4O_2$	12	12
Naphthaline	$C_{10}H_8$	26	24.5
Formic acid	CH_2O_2	9	9

And in several compounds containing nitrogen the same rule holds.

		i Estimated.	i Calculated.
Nitrobenzol	$C_6H_5O_2N$	19	18.5
Aniline	C_6H_7N	21	21
p-and *o*-toluidine	C_7H_9N	26	26

Other such compounds can not be treated with success so simply.

We may examine a few of the solid organic bodies by the same method. Let us begin with the three pairs of isomers, dextrose and levulose, mannite, and dulcite, resorcin (and hydroquinone) and pyrocatechin. The molecular heats of the two members of each of these pairs differ by 6, and we have suggested to us at once that one characteristic difference of two such isomers may be that the molecule in one of them may retain an individuality that the molecule of the other loses, and may vibrate about its position of equilibrium as a whole, so that the value of θ will contain $a = 6$, while that of its isomer will not. If we admit this, we obtain values of the internal degrees of freedom which are satisfied by assigning one degree of freedom to each atom.

		i Estimated.	i Calculated.
Dextrose levulose	$C_6H_{12}O_6$	24	25
Mannite dulcite	$C_6H_{14}O_6$	26	26
Resorcin, pyrocatechin	$C_6H_6O_2$	14	14.3

In the cases of cane sugar and anhydrous milk sugar we can not assume the difference between the molecular heats to be due to the cause previouly assigned, but if we examine the structure of these large molecules, we shall find that four of the carbon atoms are differently connected in the molecule from the other eight. If we suppose $a = 0$, and assign 2 degrees of freedom to each of the group of eight carbon atoms in the one case, and to each of the group of four carbon atoms in the other case, we obtain a fair agreement with the calculated numbers of degrees of freedom.

		i Estimated.	i Calculated.
Cane sugar	$C_4C_8H_{22}O_{11}$	52	53
Anhydrous milk sugar	$C_4C_8H_{22}O_{11}$	49	51

In levulose and dextrose one of the carbon atoms is peculiarly connected with the other constituents of the molecule. If we assign to it 2 degrees of freedom, we obtain an exact agreement with the calculated number of degrees of freedom.

When these organic solids are dissolved in water or alcohol, their apparent molecular heats, that is, the molecular heats calculated for them from the specific heats of their solutions, on the hypothesis that the specific heat of the solvent remains unchanged, are constants for all ordinary concentrations, and differ with the different solvents. These apparent molecular heats are generally greater than those of the same substance in the solid state. It may be that the dissolved molecules have so united themselves with the surrounding water as to weaken the bonds of the water molecules and have thus increased their degrees of freedom; but it is also possible that the degrees of freedom of the dissolved molecules themselves have been increased by the process of solution. If we adopt the latter hypothesis, we may construct schemes apportioning the degrees of freedom among the atoms of different sorts which will reproduce the calculated degrees of freedom.

		C	H	O	i Estimated.	i Calculated.
Dextrose	$C_6H_{12}O_6$	1	2	1	36	37
Levulose	$C_6H_{12}O_6$	1	2	2	42	42
Mannite	$C_6H_{14}O_6$	1	2	3	52	51.5
Dulcite	$C_6H_{14}O_6$	1	2	2	46	46
Resorcin	$C_6H_6O_2$	1	3	2	28	29
Pyrocatechin	$C_6H_6O_2$	2	3	2	34	35
" in alcohol		1	3	1	26	26
Phenol	C_6H_6O	2	3	2	32	33
" in alcohol		1	3	1	25	23

The supposition made before in the case of the sugar molecules, assigning different degrees of freedom to the two groups of carbon atoms, must be made again in this case.

		C_4	C	H	O	i Estimated.	i Calculated.
Cane sugar	$C_4C_8H_{22}O_{11}$	1	2	2	1	75	74
Milk sugar	$C_4C_8H_{22}O_{11}$	2	1	2	1	71	71
Maltose	$C_4C_8H_{22}O_{11}$	2	1	2	1	71	69

When we turn to the liquids which contain other atoms than those of carbon, hydrogen and oxygen, we find that for a number of them, containing atoms of the chlorine group, the calculated degrees of freedom can be reproduced by assigning one degree of freedom to each atom of carbon and of hydrogen and three to the remaining atom or atoms.

		i Estimated.	i Calculated.
Ethyl chloride	C_2H_5Cl	10	11
Ethyl bromide	C_2H_5Br	10	9.5
Ethly iodide	C_2H_5I	10	8.8
Ethyl sulphide	$C_4H_{10}S$	17	17
Chloroform	$CHCl_3$	11	11
Carbon dichloride	C_2Cl_4	14	13.3
Ethylene chloride	$C_2H_4Cl_2$	12	11.3
Ethylene bromide	$C_2H_4Br_2$	12	14
Xylol bichloride	$C_8H_8Cl_2$	22	21.7
Xylol bromide	$C_8H_8Br_2$	22	21
Xylol tetrachloride	$C_8H_8Cl_4$	28	26.5

In the case of the ordinary solid oxides, the general rule is that the calculated degrees of freedom can be reproduced by assigning 3 degrees of freedom to each metallic atom and 1 or 2 to the oxygen atom.

The chlorides and sulphides of the metals conform to the choice of 3 degrees of freedom for the metallic atom, and 3 also for the atoms of chlorine or sulphur.

A question of a peculiar kind and of special interest comes up when we examine the heat capacities of dilute aqueous solutions of electrolytes. Julius Thomsen has shown that these solutions exhibit the very remarkable peculiarity that the apparent molecular heat of the solute diminishes as the dilution increases, so that it even becomes negative after a certain dilution is reached. Now it is evident that this can not be accounted for except by supposing that the water is so associated with some part, at least, of the solute as to have its own heat capacity diminished. The heat capacity is evidently an additive property of the solution. When we think of the solute as associated with some of the water, we may conceive of the solution as made up of the following parts: (1) the water lying outside the groups of water molecules affected by the solute; (2) the undissociated molecules of the solute with the water molecules joined with them; (3) the dissociated ions of the solute with the water molecules joined with them. Each of these parts will have its own heat capacity.

This conception of the composition of a solution leads to a simple formula for its heat capacity, of the form

$$H = W + A(1-p) + Cp,$$

in which W is the heat capacity of the water used to make up the solution, p is the dissociation factor (it being understood that one gram-molecule of the solute is used in making up the solution), and A and C are constants. The A equals the heat capacity of the undissociated molecule added to the difference between the heat capacity of the water molecules associated with it and that of the same molecules when free. The C is a similar quantity referring to the dissociated ions.

The formula may most easily be tested in the form $H = W + A + Bp$, when $B = C - A$. We may determine the dis-

sociation factor from Kohlrausch's values of the electrical conductivities. Testing the formula for those solutions for which Thomsen and Kohlrausch furnish sufficient data, we find that it reproduces the observed heat capacities exceedingly well. It breaks down sometimes for concentrations so high as to contain one gram-molecule of the solute to 20 of water.

The formula obtains additional credit from the circumstance that a precisely similar formula gives excellent reproductions of the observed volumes of solutions; these volumes being also additive quantities.

In the cases examined, the constant A is positive, the constant B, negative, and the constant $C = A + B$, also negative.

		A	$-C$
Sodium chloride	NaCl	39	31
Potassium chloride	KCl	97	55
Sodium hydroxide	NaOH	32	33
Potassium hydroxide	KOH	59	51
Ammonium chloride	NH_4Cl	39	23
Hydrochloric acid	HCl	36	36
Sulphuric acid	H_2SO_4	37	43
Magnesium sulphate	$MgSO_4$	24	261

If this conception of a solution is admitted, it leads to the view that the element of the solute is associated with several, at least with more than one, molecules of water. This is not in agreement with the hypothesis made by Traube and by Poynting, by which they have explained the laws of osmotic pressure by means of molecular attractions. They suppose that one, and but one, molecule of water is intimately bound with the molecule or the ion of the solute. We can examine this hypothesis by means of the values obtained for C. This constant represents the sum of the heat capacities of the ions of a molecule and of the difference between the heat capacity of the water molecules attached to the ions and their heat capacity when free. We may express this by writing $C = a + \alpha(\varphi - s)$, in which a is the heat capacity of the ions, α the number of water molecules in the aggregations around the ions, and φ and s the two heat capacities of one water molecule. The values of C

are all negative and whether we know the value of a or not, it is certainly positive, and not less than that corresponding to the translational degrees of freedom of the ions, or 6 for a solute that spilts into 2 ions. Then $a(\varphi - s)$ is surely negative and numerically as great as $C+6$. If we set $a=2$, as Traube's and Poynting's theories call for in the case of such solutions as those of sodium chloride and hydrochloric acid, we find, from the values of C, that $\varphi - s$ is negative, and numerically equal to or greater than 18. But s is equal to 18, the heat capacity of a gram-molecule of water, and we are led to the conclusion that φ is zero or negative; that is, that the heat capacity of the water molecules united with the ions disappears entirely or becomes negative. This result is evidently inadmissible, and I am forced to believe that more than one molecule of water, in all probability several molecules, are associated with each ion.

One serious objection may be raised against this conception, namely, that if it were true the molecular conductivities of all binary electrolytes ought to be nearly the same; for the natural supposition is that the molecular aggregates are pushed by the electric force, and whatever the ions at their centers may be, they all contain about the same number of water molecules, so that they will experience about the same frictional resistance to their motion, and will move at about the same rate. We may evade this objection by considering the aggregates as unstable, and supposing the ions to slip along through continually changing groups of water molecules. This hardly seems compatible with the considerable interaction which must take place between the ions and the water molecules, to reduce their degrees of freedom as much as the figures indicate; but it is the best way out of the difficulty that I have found.

I may remind you that Jones and his fellow-workers, in their study of the freezing points and boiling points of concentrated solutions, have found deviations from the laws of van't Hoff and of Arrhenius, which they have accounted for by the assumption of the formation of such molecular aggregates as I have described.

One is tempted to follow out the suggestions of this hypothesis to see if any general relations can be found in the constants

A and C. There are really too many unknown quantities in the expressions for these constants to make it possible to proceed at all except by conjecture, and I have already rioted so much in conjecture, that to go further may seem to carry me beyond the bounds of reason. Yet, if you will indulge me, I will describe such indications of general law as I have detected. Each of the terms A and C is a sum of the heat capacity of part of the solute and of the change in heat capacity experienced by the water molecules when they unite with it. A refers to the molecules, C to the ions. We need a knowledge first of the heat capacities of the molecules and of the ions of the solute. In the case of sulphuric acid, its heat capacity in the liquid state is 34, sufficiently near the value of A, which is 37, to make it possible to suppose that its undissociated molecule either does not associate water molecules to itself or, if it does do so, does not affect their heat capacities. To get the heat capacity of the ions, I am reduced to adding together their atomic heats obtained from the tables. In all but one case where a comparison is possible between this sum and the heat capacity of the solid solute, the two agree well together. The sum for sulphuric acid is 27, agreeing with the heat capacity 26 of the solid acid. Using this number for a in the formula $C = a + \alpha(\varphi - s)$, we get $\alpha(\varphi - s) = -70$. The symbol α expresses the number of water molecules affected by the presence of each ion, of which there are 3 for each molecule of sulphuric acid. If we venture to suppose that the number of water molecules affected by each ion, is 8, the value of α is 24, and $\varphi - s = -3$. Now the heat capacity of the water molecules is 18, so that, on these suppositions, the loss of heat capacity of each water molecule due to its association with an ion of the solute is one-sixth its original heat capacity. This would involve a loss either of 3 external degrees of freedom, translational or rotational, or of one external and one internal degree of freedom. I choose the number 8 for the number of molecules of water affected by the ion, because such might be the number of those standing nearest the ion in a regular arrangement which would be compatible with freedom of motion. We may think of the ion as at the center of a cube, with the water molecules at its corners. If the ion reaches out to more distant molecules, the next larger group it will affect will contain 14 molecules.

To a close approximation the values of C and a for hydrochloric acid, ammonium chloride, sodium chloride and sodium hydroxide, lead to the same value -3 for $\varphi - s$, on the supposition that $a = 16$, or $8+8$. The same result for $\varphi - s$ is reached for potassium chloride and potassium hydroxide if we set $a = 22$, or $14+8$. In the case of magnesium sulphate the value of C is extraordinarily large, and indicates a much larger group of water molecules around the magnesium ion. That this element can affect water powerfully is shown from the circumstance that its sulphate crystallizes with seven molecules of water of crystallization,.

The values of A are not, except in the cases of hydrochloric acid, magnesium sulphate, and of sulphuric acid, already cited, the same as the heat capacities of the molecules of the solute, but are larger than they are. It is hard to account for this as we did in the corresponding case of the increased heat capacity of the non-electrolytes when they are in solution, by supposing an increase in their own degrees of freedom. We are led rather to suppose that the molecule of solute affects the surrounding water so as to increase its heat capacity. On the assumption that the number of water molecules affected is 8, except in the case of the two compounds containing potassium, and that for them the number is 14, we get in general the value 3 for the change in the heat capacity of each water molecule affected, or an increase of one-sixth its heat capacity.

Of course such statements as these are merely suggestions. I hope that in time the specific heats of electrolytic solutions will be so accurately known as to make it possible to feel certain whether or not a law really obtains in the values of the constants of the formula.

Considering the bearing of the relations that have been adduced upon the general question of the equipartition of energy, it seems to me that their general consistency with that principle, especially the way in which the heat capacities of the organic compounds can be portioned out among the atoms by means of simple assumptions about their degrees of freedom, does afford some confirmation of the principle. Mere chance can hardly account for so large a number of successful coincidences.

REPORT OF THE SECRETARY OF SECTION B.

The annual meeting of Section B, Physics, was held in the Physical Laboratory of Tulane University, in New Orleans, on December 29 and 30, 1905, and on January 1, 1906. The presiding officer was the vice-president of Section B, Professor Henry Crew, of Northwestern University.

Professor W. C. Sabine, of Harvard University, was elected vice-president for the coming year.

On December 31, the retiring vice-president, Professor W. F. Magie, of Princeton University, gave a most interesting address on "The Partition of Energy"; this address was printed in full in SCIENCE for February 2, 1906. Professor Magie gave fitting official expression of the loss sustained by Section B, and by the scientific world, in the death of De Witt B. Brace. Professor Brace was vice-president of Section B in 1901, and was one of the most enthusiastic and valued members.

Because of mutual interest in the papers offered in Sections B and D, and because the programs were short, two joint sessions of these sections were held. The program of papers presented is given below, with abstracts of those belonging to Section B; the abstracts of the other papers are given in the report of the secretary of Section D. There was ample time for full discussion of the papers, and advantage was taken of this opportunity, adding much to the enjoyment of those attending.

Although the attendance was small (there were about thirty-five present at each meeting), yet the quality of the meetings in every respect was quite up to the average, and all were unanimous in expressing the opinion that the sessions had been both profitable and enjoyable. Excursions to the pumping and drainage stations, to a sugar plantation and mill and to a sugar refinery, as well as the miscellaneous attractions peculiar to New Orleans as a city, were greatly enjoyed by those in attendance.

An Experiment on Easterly Deviation Beneath the Earth's Surface: F. W. MACNAIR, Michigan College of Mines, Houghton, Mich.

During the investigation of the cause of divergence of long plumb lines hung in the No. 5 shaft of the Tamarack Mine,* a rough calculation of the probable easterly deviation which might be expected of a body dropping forty-two hundred feet, showed it to be about 4 feet.

A deviation admitting of consistent measurement in feet was impressive enough to create a demand for an opportunity of witnessing it, and an experiment was devised to gratify this desire. It was performed at the close of a certain day's 'plumbing' in No. 5 shaft and consisted in sus-

*See SCIENCE, Vol. XV., page 994. Also *Engineering and Mining Journal*, April 26, 1902.

pending a steel sphere by a thread at the collar, getting it as quiet as possible, then burning the thread while observers below watched for its striking a prepared clay bed.

It was a little over five feet from point suspension of sphere east to shaft timbers. In a vacuum, between sixteen and seventeen seconds would be occupied in the fall. The ball failed to appear at all.

Another sphere hung in the center of the shaft compartment about three feet from the eastern timbers when dropped also failed to appear below. Afterward a sphere, presumably this one, was found lodged about eight hundred feet from the surface. Further experiments were not then feasible.

Crude as was the whole proceeding and devoid of serious purpose, it yet drew the attention of those concerned to the possibilities offered by the deep vertical shafts of the copper district of Michigan for the investigation of easterly deviation.

The author suggests that an accurate mapping of the path of a falling body beneath the surface might possibly afford interesting data bearing on the distribution of the earth's matter. He hopes at a subsequent time to present a properly elaborated plan of investigation of this path.

A Device for producing an Instantaneous Arc at any Phase of an Alternating Current: HENRY CREW, Northwestern University, Evanston, Ill.

The essential features of this instrument are as follows; (1) A pair of electrodes, one of which has a motion of pure translation; the other, a motion of pure rotation. (2) The rotating electrode is driven on the shaft of a synchronous motor. (3) The arc is fed by the same transformer which drives the motor. (4) The phase of contact between the moving electrode and the fixed one is read off on a divided circle.

The object of this device is to obtain a comparatively cold (?) carbon arc in the neighborhood of zero-phase. The region between the poles of a continuously operated carbon arc shows no carbon bands in its spectrum at zero phase. But a carbon arc of the type indicated above shows the carbon bands at the lowest phases that can be examined, say, from 0° to 2°. The explanation of this difference lies probably in the fact that, owing to the greater heat, the current of the continuous arc at small phases is carried by the *ions of the metallic impurities;* while in the discontinuous (or instantaneous) arc the conduction is made possible by ionization, by incandescence, of *carbon*, the incandescence being secured by Joule heat.

Distribution of Gas Pressure in a Closed Tube Rotating on a Transverse Axis: FRANCIS E. NIPHER, Washington University, St. Louis, Mo. (To be published in the *Transactions of the Academy of Science of St. Louis.*)

The paper is a mathematical discussion deducing the pressure at the axis, and showing that it is independent of the length l, and angular velocity ω of the tube, if the velocity $v=\omega l$ is constant. The pressure at any

other point is also determined, in terms of its distance r from the axis of rotation.

The pressure at the free end of the tube due to rotation is greater than the external pressure against the tube due to its motion through the external air. If the outer end terminates in an L with open mouth exposed to the air through which it is advancing, the air within the tube is forced out in the teeth of the wind. If the tube be also opened at the axis, the air will pass out in a current through the open end of the L at the free end of the tube.

A New Type of Frequency Meter: A. S. LANGSDORF, Washington University, St. Louis, Mo. (To be published in *The Electrical World.*) Section D.

Report of Progress in Experiments on Ether Drift: EDWARD W. MORLEY and DAYTON C. MILLER, Case School of Applied Science, Cleveland, Ohio.

At the Philadelphia meeting an account was given of experiments to detect ether drift. The observations indicated that there is no drift of the ether. It has been suggested that the negative result was due to the influence of the heavy stone walls of the building within which the apparatus was mounted. The interferometer has since been mounted on high ground near Cleveland and covered in such a manner that there is nothing but glass in the direction of the expected drift. Observations, though difficult, have been made; but cold weather interrupted them before a definite conclusion had been reached. The observations are to be completed at the first opportunity in the spring of 1906.

A Critical Analysis of Methods of Supplying Power to Branch Telephone Exchanges on the Common Battery: KARL KINSLEY, University of Chicago, Chicago, Ill. Section D.

A New Form of Mercury Still: CHARLES T. KNIPP, University of Illinois. Urbana, Ill.

This still makes use of the mercury vapor lamp. By fusing to the lamp a properly shaped condensing chamber, mercury of a high degree of purity may be obtained. The electrodes of the apparatus are mercury and are in communication with two vessels containing the supply mercury. The condensed mercury flows from the still through a long capillary delivery tube bent in the form of an S at its lower end. The action of the mercury dropping into this tube is that of a continuous mercury pump. The apparatus is initially exhausted by means of a power pump, and the arc is started by a side connection as described by Weintraub.*

In this form of still the rate of distillation is about one pound per hour, and the cost is approximately one cent per pound.

To test the action of the still zinc, amalgams were used. The test for zinc was made by the electromotive force method recently described by Hulett and Minchin.†

Phil. Mag., Vol. VII., February, 1904.

†*Physical Review*, Vol. 21, December, 1905.

One millimeter deflection of the galvanometer corresponded approximately to .0005 volt. The results are given in the following table:

No.	Zinc Amalgam.	Distillate from Zinc Amalgam.	Defl. of Galv.
2*a*	1: 700,000	——	2.17 mm.
5	——	1: 3,000 approx.	1.51 "
3	——	1: 10,000 "	1.69 "
100	1: 370,000	——	4.00 "
a	——	1: 1,740	.61 "
b	——	1: 1,740	—.19 "
c	——	1: 1,740	.55 "

From the above a deflection of 1mm. corresponds to the presence of zinc in the ratio of 1:1,500,000. In numbers *a*, *b* and *c* the ratio of zinc to mercury was definitely known. The distillate from this zinc amalgam condensed in three separate condensing chambers showed practically no trace of zinc. The degree of purity indicated above was altogether unlooked for, since the physical conditions in the still favor the vaporization of zinc. The result seemingly points to a suppressing action exerted by the electric forces upon the zinc ions. This phase of the phenomena is the subject of further inquiry.

Difference in the Coefficient of Discharge of Steam through a Single Orifice and through a Number of Orifices near Each Other: D. S. JACOBUS, Stevens Institute of Technology, Hoboken, N. J. (To be published in the *Transactions of the American Society of Mechanical Engineers.*) Section D.

Note on the Distribution of Energy in Fluorescence Spectra: EDWARD L. NICHOLS, Cornell University, Ithica, N. Y.

The fluorescence spectra of solids and liquids are, so far as known, confined to the visible wave length. Observers in this field of optics have until very recently contented themselves with a description of the appearance of the fluorescence band or bands and an indication of its approximate limits towards the red and violet. Professor Merritt and the present writer have, however, succeeded in making spectrophotometric measurements of the fluorescence of numerous substances and have published curves in which the distribution of intensities of fluorescence spectra are expressed in terms of the intensities of the corresponding wave lengths in the spectrum of the acetylene flame.*

By means of measurements of this source of light made by G. W. Stewart, and independently by W. W. Coblentz, using a mirror spectrometer with rock salt prism and a radiometer, a curve showing the distribution of

*Nichols and Merritt, *Physical Review.*

energy in the visible spectrum may be plotted. The writer* has published in a recent paper a curve based upon these data which gives the distribution of energy in the acetylene flame and has checked the values thus obtained by means of spectrophotometric comparisons between the Hefner and the acetylene flames and Angström's curve for the distribution of energy in the spectrum of the Hefner flame.

This curve makes it possible to convert the spectrophotometric curves for the fluorescence of any given substance into curves of the distribution of energy in its fluorescence spectrum, and enables us to secure data for this distribution in the case of spectra, the intensity of which is far too weak to admit of direct measurements of the energy. In the present paper such curves for four typical fluorescent solutions, sulphate of quinine in water, fluorescin, rhodamin and chlorophyll in alcohol (together with the energy curves of the absorption spectra of these substances), are presented. These curves and a discussion of their properties will be published in the *Physical Review*.

Conditions Which Change the Resistance of the Selenium Cell: F. C. BROWN, University of Illinois, Urbana, Ill.

The paper reviews the conditions that produce change in the electrical resistance of the selenium cell; light, which changes the resistance as much as ten times; heat, which changes the resistance almost as much as does light; hydrogen peroxide, which decreases the resistance thirty per cent. when the selenium is placed three cm. from the surface of the liquid; increase of E. M. F. in the circuit which may decrease the resistance as much as 1,000 times; and hydraulic pressure which decreases the resistance more than sixty per cent. The cells used were, in general, patterned after those of Bidwell.

In five of the curves which were shown, for three different cells, the pressure coefficient is quite constant, as is shown by the following approximate values: 0.00103, 0.00105, 0.00120, 0.00109, 0.00107 ohms per gram pressure.

Other conditions which produce minor changes of resistance according to different investigators are: X-rays, radium rays, Hertzian waves, ozone treated caoutchouc.

The following data for one of the selenium cells at low temperatures seem to show that the resistance is not much different from that at ordinary room temperatures, and that the sensitiveness to light is about three times as great:

*Nichols, *Physical Review*, Vol. 21, p. 147.

Resistance ohms.	Temperature deg. Cent.	16 c.p. lamp 8 cm. from cell.
86,000	—61	off
82,000	—60	off
97,000	—60.8	off, room darkened.
114,000	— 58 to —60.8	off
21,000	—58	on
17,000	—55	on after 2 min.
17,000	—53	on after 4 min.
15,800	—57	on after 6 min.
15,700	—61	on after 8 min.
15,600	—61	off
25,600	—61	off after 1 min.
28,400	—58	off after 7 min.
33,000	?	off after 19 min.
45,000	—28	off after 45 min.
75,000	—10	off after 55 min.
119,000	room tem.	off after 5 hrs.

The theory that has been most generally accepted as to the cause of decrease of resistance, is that of Bidwell. He said that it was due to a selenide which was found more or less in every selenium cell, and which made the cell a better conductor when the light fell upon it. Up to the present time, we are not at all assured that a selenide plays any important part.

Another theory has been given, namely, that light produces crystallization, and since some kinds of crystals conduct better than others, the change of resistance is due to the formation of crystals in unstable equilibrium.

Another theory is that in the selenium cell, there is a form of selenium called metallic, which conducts electricity well and which is a sort of solution with the non-conducting selenium. Light causes the metallic selenium to make better contact and thereby reduces the resistance.

As selenium has a coefficient of expansion about five times that of ordinary metals, the author was led to the study of pressure effect, thinking that the change of resistance might be due to contact differences. But this is, at present, only a theory.

Elastic After-Effects in Crystals: J. R. BENTON, Geophysical Laboratory of the Carnegie Institution of Washington, Washington, D. C.

The elastic properties of solid bodies vary with different specimens of the same substance, and in the same specimen when it is subjected to varying preliminary treatment. There is reason to believe that the discrepancies are due to irregularity of structure, such as is known to exist in metals and many other solids. If this explanation is correct there should be no irregularity in the elastic behavior of single crystals. To test this,

experiments were planned for observing the elastic after-effect, elastic hysteresis and permanent set, in crystals. The present paper describes the first part of these experiments, which deals with elastic after-effect. Observations were made on the torsion of mica, and on the flexure of selenite, kunzite and rutile; they show that the elastic after-effect is not entirely absent, as was hoped would be the case, but is very small as compared with that in most solids. The reason why it appears at all probably lies in the fact that absolutely perfect crystals can not be secured for the experiments.

The Percentage Bridge: A. C. LONGDEN, Knox College, Galesburg, Ill.

Five or six years ago, a paper entitled "A Percentage Bridge," was presented to the American Association for the Advancement of Science, and also to the American Institute of Electrical Engineers, by Mr. H. C. Parker, of Columbia University.

The instrument is a four-gap slide wire bridge in which the two inner gaps are used for the comparison of resistances, and the auxiliary resistances in the outer or end gaps have such a relation to the resistance of the bridge wire that a change of a hundredth of one per cent. in the ratio of R_1 to R_2 shall produce a change of one millimeter in the position of the balancing point on the bridge wire. The test coil, however, is not balanced directly against the standard, but one of the resistance gaps is used as a substitution gap; a standard resistance in this gap is balanced against a resistance approximately equal to it, and then the test coil is *substituted* for the standard and the bridge is again balanced. The method does not *eliminate* the resistance of the end connections, but it makes the total value of the end resistances so *large* that even if they differ by a hundredth of an ohm, the error in the result will only be one part in twenty million!

A mercury commutator is suggested for substituting one coil for another in the percentage bridge, which is less complicated than the Carey Foster commutator. The most serious disadvantage of the percentage method is pointed out and a remedy suggested.

The percentage bridge is an instrument of great simplicity, sensitiveness, and range; and the standard resistances are automatically protected from heavy currents. It is not only a very superior instrument for the comparison of standard resistances, but one which lends itself admirably to a variety of special purposes, such as calibrating rheostats, determining temperature coefficients, etc.

Priming Caused by Poor Circulation in a Boiler: D S. JACOBUS, Stevens Institute of Technology, Hoboken, N. J. Section D.

Dual Degree for Engineering Courses: P. C. NUGENT, University of Syracuse, Syracuse, N. Y. Section D.

Panama: Discussion of Present Conditions and the Prospect: F. L. WALDO, New York, N. Y. Section D.

Panama: A Sea-Level Canal: W. R. WARNER, Cleveland. Ohio. Section D.

DAYTON C. MILLER,
Secretary.

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ADDRESS

BY

LEONARD P. KINNICUTT,

VICE-PRESIDENT AND CHAIRMAN OF SECTION C FOR 1905.

THE SANITARY VALUE OF A WATER ANALYSIS.

Twenty years ago, the vice-president of this section, the late Professor William Ripley Nichols, took as the subject of his address, "Chemistry in the Service of Public Health," saying: "If any are inclined to criticize my choice of that branch of applied chemistry with which I am most familiar, I trust they will consider that, after all, few of us have the opportunity, or, let us confess it, the ability to carry research and speculation to the height to which chemistry is capable of rising." Agreeing fully in the sentiment of this last sentence, though not at all as applying to Professor Nichols, whose marked ability as an investigator was recognized by all, I feel that I can best fulfill the clause in our constitution which requires the several vice-presidents to give an address before their respective sections, by taking for my address a subject that does not call for the speculative thought of theoretical chemistry, but rather the careful consideration of some one subject in my own field of work. I have, therefore, chosen as my topic "The Sanitary Value of a Water Analysis."

A question of great importance to a community is the character of its water supply, and of equal importance to the individual is the purity of the water that is used in his household, whether it comes from a city main, or an isolated well in the country. That this was not always so considered hardly requires mention, for it is not a great many years since disease was considered a direct visitation of Providence. The first investi-

gation that attracted public attention to the fact that there might be a connection between the use of polluted water and disease may be said to be what is known in sanitary science as the "Broad Street Well Investigation." In the epidemic of cholera in London in 1854, the parish of St. James, Westminster, which in previous epidemics had suffered, on the whole, less than many other parts of London, suffered most severely, the death rate reaching two hundred in ten thousand. The whole parish was not equally affected, and the center of infection, or the special cholera area, was in the neighborhood of Broad Street, and attention was drawn to the fact that, though city water was supplied to the district, a well situated on Broad Street was used to a very large extent for household purposes. An investigation followed, and it was shown that of the deaths that occurred during the first week of the outbreak among persons living in this neighborhood, 82 per cent. were known to have used the water from this well, and that houses and factories in the same radius where the water from this well was not used seemed to be exempt from the disease.

A strong case between cause and effect was thus made out, and when a subsequent examination showed that there was direct leakage from an open privy into this well, it established as clearly as could be done by circumstantial evidence that the epidemic in St. James parish in 1854 was caused by polluted water.

A further striking proof that sewage polluted water may become the effective vehicle of the actual poison of disease, was furnished through the cholera epidemic in London in 1866, but the theory that water is one of the most dangerous carriers of infection of cholera and of typhoid fever may be said to date from 1872, and to have been the result of the careful investigation of the typhoid fever epidemic in that year in Lausen, Switzerland. To-day we recognize as one of the best established theories of sanitary science that both cholera and typhoid fever are water-borne diseases, and that the primary cause of the large death rate from typhoid fever is due to the use of polluted waters.

The late Professor Thomas M. Drown divided all waters into two classes, namely, normal and polluted waters, and stated, as regards normal waters, that although they differ very widely in

character from the pure colorless mountain brook to the dark-colored water from swampy ground, they are all characterized by never having received any contamination connected with man, and although often far from pure waters, differ from a polluted water in one most important respect, in that they are not capable of producing, as far as known, any specific germ disease.

It is true that many normal waters, on account of the large amount of vegetable matter they contain, are unfit for household use, although they may be sanitarily safe waters in the sense of not being the vehicle of the germs of disease. Hence the sanitary value of a water analysis depends not on determining the amount of organic matter which a water contains, but on the amount of information it can give in answer to the question, "Is a given water a normal or a polluted water?" or, stated in other words, "How far can analysis determine whether or not the organic matter in a water is of vegetable or animal origin?"

In order to answer this question it is necessary to divide natural waters into three classes: surface, subsoil or ground, and artesian waters. These waters differ so radically in character from each other that, although the data from which deductions can be drawn as regards pollution are practically the same, yet the correct interpretation of these data depends upon the knowledge as to which group the water in question belongs, and a clearer idea of the subject under discussion can be obtained if we first consider surface waters and apply the results of this study to ground and artesian waters.

It is often claimed that there is no value in a sanitary analysis of a surface water, that an inspection of the watershed may give all, and often much more, information than can be obtained from the analysis of the water. If sewage is seen to be entering a pond, an analysis is unnecessary to show that it is polluted. If the watershed is uninhabited, the water can not be polluted.

There is no question about the value of a survey, and that a survey not only aids in drawing the proper deductions from the data of an analysis, but that often it is necessary for a correct explanation of the data. Still, there are many cases where, unless large interests are involved, a careful and complete survey is practically impossible on account of the expense, and

where the chief reliance must be placed on the sanitary analysis. Further, a survey alone, though it may show pollution, does not tell the amount of pollution, nor show the changes that have taken place in the polluting substances. A survey alone can never give all the desired information, and a sanitary analysis, even of a surface water, must always have a value. It is from this point of view that what I have to say regarding surface waters must be considered.

Very early in the study of polluted waters, attempts were made to devise methods for detecting certain definite organic compounds which were known to be formed by the decomposition of the nitrogenous products contained in sewage, but without success, and there is very little hope that much knowledge can be gained as to the nature of the organic matter through this line of investigation. The decomposition of the nitrogenous products contained in sewage takes place so rapidly that the isolation of any particular compound like crystin, or any group of compounds, like the amido group, can only be looked for when the pollution is very recent and in very large amounts.

Though it is apparently impossible to isolate from a water any particular nitrogenous organic compound known to occur in sewage, the amount of nitrogen and the amount of carbon contained in these compounds can be determined, and among the first, if not the first, to attempt to determine from the amount of nitrogen and carbon in a water whether the organic matter was of animal or vegetable origin was the late Sir Edward Frankland. On examining the residue left on evaporation of water from peat bogs he found the ratio of nitrogen to the carbon was as 1 to 12, while in the residue from fresh sewage it was as 1 to 2.1, and in the residue from polluted waters, as water containing leakage from cesspools as 1 to 3.1. From these and similar observations he concluded that in surface waters the ratio of the organic nitrogen to the organic carbon in the residue left on evaporation of such waters afforded trustworthy evidence as to the source of the organic matter. Thus he concluded that if the ratio was as slow as 1 to 3 the organic matter was of animal origin; if as high as 1 to 8 it was chiefly, if not exclusively, of vegetable origin; and that if the

ratio was between these two proportions the analyst must be guided in his opinion by the amount of inorganic nitrogen the water contained, and by his knowledge of the surroundings of the source of the water.

This work of Frankland deserves much closer study than it has as yet received. His idea that reliable information regarding the source of the organic matter in a water can be obtained from a knowledge of the amount of organic carbon and organic nitrogen is, in my opinion, undoubtedly sound. The reason why this method has not been more generally adopted is undoubtedly due to the difficulties in correctly determining these two factors by the process used by Frankland, which consisted in measuring the amount of carbon dioxide formed, and the amount of nitrogen given off, by the combustion of the residue left on evaporation. If as simple a process for determining the organic carbon as we now have for determining the organic nitrogen could be devised, I believe Frankland's method for deciding upon the character of a surface water would receive the careful study it certainly deserves.

The method of determining the character of a water from the ratio that exists between the carbon and nitrogen being recognized as of comparatively little practical worth, on account of the difficulty of determining the carbon, attention to-day is concentrated upon the nitrogen content of a water.

The usual method used for determining the nitrogen in the undecomposed nitrogenous compounds is the albuminoid ammonia method of Wanklyn. It gives only an approximation of the total amount of nitrogen thus occurring, but taken in connection with the free ammonia present, it undoubtedly often gives valuable indications as to the source of the nitrogenous compounds.

In fresh sewage the amount of nitrogen as free ammonia is from three to four times that of the nitrogen in the albuminoid ammonia, and in sewage effluents from twenty to thirty times; while in peaty water or water containing an infusion of leaves, the nitrogen in the albuminoid ammonia is from ten to twenty times the nitrogen in free ammonia; hence when a surface water, not including rain or snow water, gives a greater amount of nitrogen as free ammonia than it does as albuminoid ammonia,

the indications are that the water has certainly been polluted by sewage and that the source of the organic matter is of animal origin, and with a large amount of nitrogen as albuminoid ammonia (over twenty-five-hundredths of a milligram per liter), a ratio of the nitrogen of the free ammonia to the nitrogen of the albuminoid ammonia of less than 1 to 5 is suspicious.

Free ammonia contained in a water may be rapidly removed by plant life or be changed into nitrites and nitrates, and then be absorbed by algal forms, the plant life thus stimulated again adding to the water undecomposed nitrogenous compounds. Consequently, while a low ratio as 1 to 5 between the nitrogen of the free ammonia and the nitrogen of the albuminoid ammonia indicates pollution, the reverse can not be said to be a strong indication that the water is a normal water, one containing only vegetable matter.

It is a well established fact that it is not safe to form a judgment of a water from the consideration of any single nitrogen factor, and that unpolluted surface waters are known where the nitrogen, as albuminoid ammonia, is much larger than in certain waters known to be polluted, and the same can also be said of nitrogen as free ammonia and the nitrogen as nitrites and nitrates, and yet something can be learned from the consideration of each of these factors. Nitrogen as albuminoid ammonia in a water analysis, as has been said, represents the nitrogenous matter which has not undergone decomposition, and it is found that in unpolluted waters this amount varies greatly, some waters giving almost no nitrogen in the above form, others as much as one milligram per liter. If, however, the nitrogenous substances are of vegetable origin the water is usually highly colored; and consequently, a colorless water, containing that amount of nitrogenous matter represented by 0.25 milligram of nitrogen as albuminoid ammonia per liter is looked upon with suspicion.*

*It has lately been suggested that the determinations of organic nitrogen should be substituted for the determinations of nitrogen as albuminoid ammonia in water analyses. There is, of course, no question that nitrogen as albuminoid ammonia only gives the amount of nitrogen that is present in nitrogenous substances decomposed by an acid solution of potassium permanganate, and not the total organic nitrogen. With

Free ammonia always indicates organic matter in the process of decomposition. In unpolluted surface waters it is rarely high, being removed almost as fast as formed by vegetable and animal organisms in the water and an amount of nitrogen as free ammonia above 0.05 milligram per liter is unusual, and if it does occur the water can not be considered as an unpolluted water unless that fact is clearly established by other data.

In drawing conclusions, not only from the nitrogen as free ammonia, but also from the ratio that exists between the nitrogen as free ammonia and the nitrogen as albuminoid ammonia, what is know as the "seasonal variation" must be considered, namely, that the amount of nitrogen as free ammonia in northern surface waters is usually greater during the late autumn and early winter than at any other time. This is due to two facts: first, that in cold weather the free ammonia is not absorbed quickly by plant life, and second, that as cold weather begins the surface water of ponds and reservoirs, growing colder, sinks and the bottom water rises, bringing with it the decaying matter from the bottom, increasing the amount of free ammonia often to three times the average amount of the year. This also affects to a certain extent the nitrates, but not nearly to the same amount.

The nitrogen in the other two nitrogen factors of the nitrogen content occurs only in very small amounts. Nitrites in a water are due either to the oxidation of ammonia or to the reduction of nitrates, and being unstable quickly undergo change. For-

waters, however, unless greatly polluted, the amount thus obtained equals approximately one-half of the organic nitrogen, so that the organic nitrogen, if desired, can be calculated sufficiently closely from the nitrogen of the albuminoid ammonia. In sewage work, however, the case is very different. There is no fixed ratio between the organic nitrogen and nitrogen as albuminoid ammonia, and in determining the strength of a sewage, and in determining the amount of purification that takes place in various processes of treatment, the organic nitrogen is a most important factor and should be determined. The nitrogen as albuminoid ammonia, on the other hand, is of little value, changing as the sewage ages on account of nitrogenous substances not acted upon by an acid solution of potassium permanganate breaking down, giving nitrogen compounds more easily decomposed. The amount of nitrogen as albuminoid ammonia, as a rule, increases as the sewage ages.

merly, nitrogen as nitrates in amounts exceeding 0.002 milligram per liter were thought to be a strong indication of recent pollution, and though we now know that unpolluted swamp waters may contain over twice that amount, still, more than 0.002 milligram is an unfavorable indication.

Nitrogen in the form of nitrates indicates the amount of nitrogenous matter that has undergone complete decomposition. It is rarely absent from a normal water. It is never present in any large amount, seldom exceeding one tenth of a milligram perliter. Higher amounts than this, being unusual, must be looked upon with suspicion,

The interpretations I have just made apply chiefly to reservoir, pond and lake waters. River waters differ from pond, lake or reservoir waters in the essential particular that the former are in rapid motion and the so-called nitrogen cycle may take place many times during the course of their flow. High nitrogen as free ammonia, as albuminoid ammonia and as nitrites, characteristic of recent pollution in ponds and reservoirs, may, in rivers, be due to the decomposition of the algæ life, which was stimulated by the entrance of sewage in the upper stretches of the river, and the proper deductions to be drawn from these nitrogen data necessitate a knowledge of the river.

Though much valuable information can be obtained, as I have tried to show, from the careful study of the nitrogen content of a water, the water analyst does not depend alone upon these factors in forming an opinion as to the source of the organic matter, and turns to other chemical as well as to bacterial data to substantiate or modify the opinion thus formed. From the chemical point of view the most important of these data is the combined chlorine that a water contains. This is due to the fact that though chloride of sodium occurs in rain water, especially near the sea, and in small amounts is found in all soils, it is a characteristic constituent of sewage, the animal body expelling the same amount of salt as it absorbs.

A careful study of the amount of combined chlorine in normal waters made by Professor Thomas M. Drown, showed that in Massachusetts, where salt-bearing strata do not occur, the amount of chlorine in a surface water depended on its dis-

tance from the sea, and that for Massachusetts it was possible to establish normal chlorine, or, as they are commonly called, iso chlor lines.

The work begun by Professor Drown has been carried on by other investigators, and to-day the iso chlor lines for all the New England States and New York and New Jersey have been demined. The result of this work is that the amount of chlorine occurring in the surface waters of the above-named states gives most valuable information. Chlorine above the normal of the region shows pollution. It does not indicate whether the pollution is direct or indirect, but does show that sewage, from which the organic matter and the germs of disease may or not have been removed by filtration through soil, has had access to the water. Chlorine above the normal is therefore always a suspicious sign which must be investigated. I know that it is claimed that in many of the western states, owing to geological conditions, very little information can be obtained from the determination of chlorine. I believe, however, more careful and thorough work is necessary to prove that such is the case, and that further investigation may show that though it is impossible to construct iso chlor lines running through the state, the normal chlorine of different localities in a state can often be determined.

Another factor that is often used in the attempt to decide whether or not a water contains an excessive amount of organic matter is the oxygen consumed. The oxygen consumed is not, however, a measure of the organic matter in a water, but only a measure of the amount of mineral reducing salts plus a certain amount of the organic matter, the amount depending on the method of determination used. It gives, in my opinion, very little information as to the character of the organic matter, and is only valuable when different surface waters are to be compared with each other, or when used in filtration experiments.

The same may be said as regards color, turbidity and the amount of mineral matter that a surface water contains, that, though of essential importance in deciding on the value of a normal water as a potable water, they give little information as to pollution.

In the early days of bacteriology it was claimed that the final criterion as to pollution of a water would be furnished by aid of that science, and though this hope has not been fulfilled, the information that can be gained by a bacterial analysis is often of the highest importance. It not only aids in the interpretation of the chemical data, but may of itself show, almost without question, that a given water is polluted, for though attempts to isolate special pathogenic germs have generally failed, even in waters known to contain these forms, characteristic sewage forms, like the colon bacillus, can be isolated if they occur in any number in a water. Occurrence of numerous characteristic sewage bacteria can point only to one thing, pollution, and if such forms are found there is no question that the water receives sewage drainage. Bacteriology, however, can not determine, except very roughly, the amount of pollution, or the present condition of the polluting matter, nor does it give but very little, if any, information as to past pollution. If the pollution is recent and of any considerable amount, a careful bacterial examination will show the fact, and probably better and more convincingly than any chemical analysis. If the pollution is more remote, more information can, as a rule, be drawn from chemical than from bacterial data. If the polluting matter has filtered through the soil before entering the water, bacterial work will not indicate the fact.

As a general statement, it may be said that a bacterial analysis, while giving information as regards recent and continuous pollution, gives no information as to the past history of a water, and in this respect differs from a sanitary chemical analysis.

All natural waters contain bacteria, and even if the true colon bacillus does not occur in many normal surface waters, one closely akin to it can often be found if a sufficient amount of the water be taken for examination. The mere presence of bacteria or even the colon bacillus, if found only in large volumes, does not, therefore, signify pollution.

The number of bacteria found in a surface water depends not only upon the organic matter a water contains, but to a greater or less extent upon various natural causes, such, for instance, as the character of the soil of the watershed, the rainfall, the time of year the examination is made, and these consid-

erations must be taken into account when attempting to determine the character of the water from the number of bacteria present. Arbitrary standards have been proposed from time to time, and of these Dr. Sternberg's, that a water containing 500 bacteria to the cubic centimeter is open to suspicion and one containing over 1,000 bacteria is presumably contaminated by sewage or surface drainage, is probably as satisfactory as any that could be devised. Though most artificially filtered waters and many reservoir waters contain not over 100 bacteria to a cubic centimeter, to state that a surface water showing on a single examination a much greater number than 500 per cubic centimeter was probably polluted, would be unjustifiable, and the significance of the data can only be determined when the average bacterial count of the water under examination is known, or when it is considered in connection with the chemical data.

A certain added amount of information may be gained as to the weight to be placed on the total bacterial content of a water, by also determining the number of colonies that develop on agar plates at blood temperature and the number that decompose lactose with the formation of acid. According to Rideal and also to Winslow, in an unpolluted water the proportion between the total number of colonies obtained on gelatine plates at 70° Fahrenheit, and the number obtained on agar plates at 98 degrees Fahrenheit should not be greater than 12 to 1, and Winslow and Prescott state that in normal Massachusetts waters the total number of organisms growing at the body temperature rarely exceeds 50 per cubic centimeter, and that acid producers are generally absent.

The information that can be obtained by the examination of a water for the colon bacillus is much more positive and important than that which can be obtained from a bacterial count, for though undoubtedly the colon bacillus is not confined to the secretions from mammals, the intestines of the higher vertebrates form a better environment for its growth and multiplication than any other which occurs in nature, consequently drainage from domestic and agricultural wastes of human life must be considered as the method by which large numbers gain access

to surface waters. It follows, therefore, that a water containing large numbers of colon bacilli must be looked upon as a polluted water, and the generally accepted statement of to-day is that if the colon bacilli occur in sufficient numbers in a surface water to be detected in the majority of one cubic centimeter samples tested (at least six samples being taken), it is almost positive indication of recent sewage pollution. Failure to detect colon bacilli when water is thus tested is not, however, a proof that the water is a normal water, though it is usually a proof that the pollution, if it exists, is not recent nor continuous.

Having attempted to give what I believe can be learned from the sanitary analysis of a surface water, ground and artesian waters remain to be considered, and with these waters the analyses assume far greater importance than with surface waters, for the area of the source of the water is often indefinite and rarely determinable with accuracy, and a careful and complete survey of what may be called the watershed is very difficult and generally impossible.

In determining the character of a ground water we make use of the same data that we have considered in speaking of surface waters, but the deductions drawn from the data are very different. This is due to the fact that the two waters differ so greatly in their chemical and biological characteristics that they can not be judged by the same standards.

Ground waters are surface waters which have percolated through the soil, and the changes which they have thus undergone are very similar to the changes which take place in the process known as slow sand filtration, and it is from a study of this process that we are able to follow the changes that take place when surface waters pass into the soil.

In slow sand filtration of water we find that odor, color and turbidity are removed; that about 90 per cent. of the nitrogenous organic matter is oxidized, and that a part, varying from 50 to 75 per cent. of the nitrogen of the organic matter, is found in the filtrate as nitrates; that the amount of chlorine remains unchanged and that the bacteria are to a very large extent removed.

To apply the information thus obtained to ground waters it can be stated that an unpolluted ground water should be free from color, odor and turbidity, that the amount of nitrogen as free and albuminoid ammonia should be very much less than in an unpolluted surface water, that the amount of nitrogen as nitrates should not exceed by more than 50 to 75 per cent. the nitrogen of nitrates of normal waters, and that the amount of chlorine should be the chlorine of the region, and bacterially the water should be very pure.

To go further, and from the filtration experiments and from the study that has been made during the past twenty years on ground waters, and express the statements of the last sentence in concrete numbers, it might be said that the best ground water should certainly contain not over 0.01 milligram of nitrogen as free ammonia or over 0.02 milligram of nitrogen as albuminoid ammonia, no nitrogen as nitrites, not over 0.1 milligram of nitrogen as nitrates in a liter of water, and chlorine not above the normal of the region. When a water contains more than 0.05 milligram of nitrogen as free ammonia, and 0.08 milligram of nitrogen as albuminoid ammonia, or 0.12 milligram of nitrogen as albuminoid ammonia, even if the free ammonia occurs in very small amounts, it is a sign of imperfect filtration or of subsequent pollution, and consequently such water should not be used for household purposes.

In making this statement, the fact that the nitrogen of organic matter in a soil can be oxidized by ferric oxide to ammonia has not been lost sight of. This is, however, not of common occurrence, and unless it can be proved in a given case to have taken place, the deductions that have been made must be considered as correct.

Nitrites in a ground water are a most unfavorable indication, though they are sometimes found in unpolluted well waters due to the reduction of nitrates by iron sand, or iron pipes through which the water is drawn from the well.

A ground water containing an amount of chlorine much in excess of the normal of the region and nitrogen as nitrates approaching 3 milligrams per liter, even with very small amounts of nitrogen as free and albuminoid ammonia, must be considered

to have been originally polluted surface water, and on this account not a water free from possible danger.

Though, as has been stated, the number of bacteria in a ground water should be small, not over one hundred per cubic centimeter, numerous investigations of well waters giving no indication of pollution have shown that this number is often largely exceeded. This may be and is often due to the falling into a well of air and soil bacteria. The number of bacteria in well water, if not reaching into the thousands, can not, therefore, of itself be considered as an indication of pollution, though the cause of excessive numbers requires explanation.

A much better indication as to the pollution of ground waters is the ratio that exists between the number of bacteria developing at the temperature of 70° Fahrenheit and the number developing at blood heat, and the same conclusions as with surface water may be drawn from the ratio that is thus found.

The occurrence of acid-forming bacteria indicates pollution and the presence of colon bacillus in a ground water is almost positive proof that sewage drainage is present.

Artesian or underground waters are ground waters which have passed into or through underlying rock strata. The sanitary value of the analyses of such waters should be very great, for the pollution, if polluted, may be due not only to carelessness, which allows direct and continuous contamination from above, at the point where the water is tapped, but often to ground water which has not been purified by filtration through soil having direct connection with the water in the well, owing to the seamy or faulty character of the rock or to the percolating water wearing channels through the rock, as often occurs in limestone formations. The source of pollution may, therefore, be many miles from the well, and though careful study of the geological formation, the dip of strata and general characteristics of the neighborhood should be made, the main reliance for deciding whether or not the water is a polluted one must often be the data obtained from the chemical and bacterial analyses.

Unfortunately, however, in the study of artesian water, perplexing chemical and bacteriological results are often obtained.

In artesian waters so situated that surface pollution seems impossible, amounts of nitrogen as free ammonia, as nitrites and as nitrates have often been found which, if occurring in ground waters, would cause them to be considered as polluted. The nitrogen of the nitrates in these waters way be due to fossil remains, and the nitrogen as nitrites and as free ammonia to the reduction of the nitrates by chemical action, as contact with iron sulphide, and the occurrence of the nitrogen as free ammonia, also sometimes to some salt of ammonia existing in the strata through which the ground water passes. On this account the determination of the nitrogen content does not give as satisfactory data from which to draw conclusions as those obtained from the analysis of ground water.

The interpretations of the data obtained, however, always bearing the above facts in mind, are nearly the same as those stated when considering ground waters. An unpolluted artesian water should not contain any nitrogenous or carbonaceous organic matter and consequently the nitrogen as albuminoid ammonia should not be over 0.02 milligram per liter and the oxygen consumed, nitrites and mineral reducing substances being absent, should not exceed one-tenth of a milligram.

The chlorine factor is of much less importance in the study of artesian waters than in the other two classes, for, as a rule, we have little or no knowledge of the normal chlorine of deep waters of any given region, and consequently this datum has only the same value that it has in the analysis of surface waters in localities where the normal chlorine has not been determined.

Bacterially an artesian water should be a very pure water, and at one time it was considered that an unpolluted artesian water was a sterile water. To-day, however, this is not the case. Examination of wells has shown that while in a few cases the water may be sterile, in the majority bacteria are present in varying numbers. These are, however, generally of slow-growing types and are not indicative of pollution. Should an artesian water, not in a region of thermal springs, show bacteria which develop in considerable numbers at the body temperature, the interpretation would be the same as in a ground

water that unpurified water or sewage was entering the wel either from the immediate environment or through fissures and crevices in the lower strata. Acid-forming bacteria and the colon bacillus should never be found in artesian waters.

I am afraid I have already occupied by far too much of your time in giving my opinion as to the sanitary value of a water analysis and the information that can be derived from such an analysis, and in conclusion would only reiterate that to form a judgment as to the wholesomeness of a water from the data of a sanitary water analysis, the source of the water, whether surface, ground or artesian, must be known; that a survey, of a surface water, though it may show whether or not the water is polluted, does not give information regarding the amount or condition of the polluting matter; that with ground and artesian waters it often gives very little information, and that an opinion regarding the character of such waters must, as a rule, depend on the sanitary analysis.

REPORT OF THE SECRETARY OF SECTION C.

The meetings were held in the chemical laboratory of Tulane University. In the absence of C. F. Mabery, Section C was presided over by L. P. Kinnicutt.

At the first meeting the minutes of the preceding meeting at Philadelphia were read by the secretary. J. H. Long was elected a member of the Council of the Association, Charles H. Herty a member of the General Committee, W. J. Gies a member of the Sectional Committee and C. E. Waters, Press Secretary.

J. H. Long read the report of the committee on tax-free alcohol for manufacturing purposes.

In the afternoon the retiring chairman, L. P. Kinnicutt, delivered an address on "The Sanitary Value of a Water Analysis."

The American Chemical Society was then called to order by F. P. Venable.

Harvey W. Wiley delivered an address on "Some Important Problems in Agricultural Chemistry."

The realm of agricultural chemistry was formerly supposed to be confined to examinations of soils and fertilizers. In late years, however, investigations of agricultural chemistry have extended far beyond the original confines. The term agricultural chemistry no longer represents a kind of chemistry, but the field in which all kinds of chemistry are utilized.

It is true that there are many problems yet unsolved relating to the source of plant fertility and even to definitions. For instance, the chemists and botanists use the term plant food in a different sense, thus creating more or less confusion.

The chemist regards plant food as that which enters the plant from without and is utilized for its growth and development. The botanist does not regard water and carbon dioxide as plant food, but only as food materials, which do not become real foods until united by photosynthesis.

In this country another problem relates to the supply of potash, which it is possible may yet be obtained by grinding potash-bearing feldspars.

Another problem relates to the composition and nutrition of foods. This problem now occupies the attention of a great many agricultural chemists, who, perhaps, are known also as physiological chemists.

The realm of physical chemistry is important here, since most of the phenomena of plant growth rest upon the principles of physical chemistry. Agricultural chemistry also follows foods through their preparations, and supervises their purity and ascertains their nutritive value.

Agricultural chemistry also has occupied the field of technical chemistry in all the processes which utilize the raw material produced from the field, the forest and the farm. Thus the chemical problems of tanning, paper making, sugar manufacturing, etc., come within the domain of research of agricultural chemists of the present day.

It is thus seen that every department of chemical activity and research may be utilized for the advantage of agriculture.

Dr. Wiley was followed by Louis Kahlenberg, whose address on "Recent Experimental Researches in Osmosis" will appear in the *Journal* of the society.

On Saturday morning Wm. L. Dudley delivered an address on "Laboratory Designing and Construction." His ideas on the subject were illustrated by plans for a chemical laboratory. James F. Sellers followed with an address entitled "A Symposium on Chemistry Requirements in the South."

C. A. Browne, Jr., told of "Recent Developments in Industrial Chemistry in the South."

The writer restricts his paper very largely to Louisiana. The developments in the fertilizer industry, manufacture of ice, preservation of wood, distillation of turpentine, tar, methyl alcohol, etc., from wood, and the utilization of wood waste for the manufacture of ethyl alcohol by Claassen's process are briefly discussed. The utilization of cottonseed by-products in a number of new ways is alluded to, and reference is made to a new process for extracting oil from rice and the improvement of the rice by-products for cattle feeds. The remainder of the paper is devoted to a discussion of recent developments in the sugar cane industry, particular stress being laid upon the recent work in improving the varieties of sugar cane and in the utilization of the by-products of the sugar house—the bagasse and molasses.

The address of the retiring president of the American Chemical Society, F. P. Venable, was on "The Growth of Chemical Research in the United States." It will appear in the *Journal of the American Chemical Society.*

At the meetings of the different sections the following papers were presented.

PHYSICAL CHEMISTRY.

The Antimony-Tin Alloys: W. D. BANCROFT.

Reinders thought antimony and tin formed two series of solid solutions and two compounds. It is now found that no compounds occur and that there are four series of solid solutions. The crystals, counting from the antimony end, are unstable below 309°. The paper published in the *Journal of Physical Chemistry.* Vol. X, p. 141.

Amorphous Sulphur: ALEXANDER SMITH and R. H. BROWNLEE. (By title.)

The Thermochemistry of Chemical Combination: J. W. RICHARDS.

The paper discussed the real heat representing chemical combining energy, and one conclusion was that in order to eliminate from the measured heat of combination all physical heat effects, the reaction should take place from solid constituents to the gaseous products; because if liquid or gaseous constituents are brought together, the heat evolved will contain their latent heats of fusion or vaporization, and if the product condenses to the liquid or solid state, the heat evolved will contain its latent heat of vaporization or sublimation. The real chemical heat of reaction is that of solid constituents to gaseous products at the absolute zero. The heat of reaction at any other temperature is then equal to

$$Q_T = Q_0 + T \quad (S_m \text{ constituents} - S_m \text{ products}),$$

where Q_T is the heat of the reaction at any absolute temperature T, Q_0 true heat of chemical combination at the absolute zero, S_m the mean specific heat from absolute zero to T. Another way of expressing this is the well-known Helmholtz formula

$$Q_T = Q_0 + T \frac{dQ}{dT},$$

where the differential coefficient represents the *mean* variation of Q with changing temperature between absolute zero and T.

The paper further discussed the great thermochemical generalization that the heat of formation of salts taken to dilute solution is additive, and concluded therefrom that (1) a salt in dilute solution is in a condition closely analogous to the gaseous state; (2) that the phenomena of osmotic pressure also substantiate this view; (3) that since for this condition the first great generalization of the thermochemistry of chemical combination has been discovered, and applies with exactness, that, therefore, the state of being in dilute solution is without question the most uniform and complete state of chemical combination known, thus absolutely debarring any idea of dissociation in any sense whatever.

The paper concludes with a careful discussion and tabulation of the most probable values of the thermochemical constants of bases and acid radicals, on the arbitrary basis of hydrogen gas being zero.

On the Specific Inductive Capacity of Solutions of the Oleates of the Heavy Metals: LOUIS KATHLENBERG.

The Separation of Solutes from Solvents by Absorbing Media: F. K. CAMERON and J. M. BELL.

Examples of the separation of organic solutes (dyes) from water or from one another, their separation from inorganic substances, and the selective absorption of ionized products were given. The absorbing media principally used were blotting paper, cotton and soils. A specially interesting case on account of its wide practical significance, was the absorption of the base from blue litmus test papers or solutions, leaving the residue apparently acid. An important practical feature of such separations is the relative rates at which solutes move capillarily through the absorbing media. It was found that such movements followed an empirical law, $y^n = kt$, where y represents the distance through which the movement has taken place, t the time of movement and n and k constants depending on the nature of the substances used, although n approximated 2.3 in most of the cases to which the formula has so far been applied. While this formula appears to hold remarkably well when neither the distance nor time is large, it ceases to hold whenever one of the variables assumes any considerable magnitude as in the cases so far recorded in the literature. For instance, the movement of water in soils has generally been measured at intervals of many hours or days, and through secondary gravitational or possibly other effects this formula ceases to hold. For the study of separations, however, the formula gives promise of much usefulness.

Molecular Absorption: F. K. CAMERON and B. E. LIVINGSTON. (By title.)

The Absorption of Phosphate by Soils: OSWALD SCHREINER and G. H FAILYER.

In view of the importance of the subject to a proper understanding of the chemistry of the soil and of soil solutions, a systematic study of the behavior of several soil types toward different phosphates was made. The phosphate solution was percolated through the soil at a slow and constant rate in an apparatus especially designed for this purpose. The separate fractions were then analyzed for phosphate and thus the amount absorbed by the soil determined. The graphical representation of the results indicates that the soils are approaching a saturated condition for phosphate, as is shown by the fact that each curve is evidently approaching a horizontal asymptote. It has been found that these absorption phenomena are quite accurately described by the differential equation.

$$\frac{dy}{dv} = K(A - y),$$

which is of the same form as the equation for a reaction velocity of the first order and other analogous processes. Integrating we get

$$\log(A - y) - \log A = -Kv,$$

where K is a constant, A the maximum amount of phosphate the soil can take up under the conditions of the experiment, and y the amount it has taken up when the volume v of the phosphate solution has passed through the soil. A may, therefore, be defined as the specific absorptive capacity of the soil for phosphate. This absorptive capacity for phosphate varies greatly in different soils, being most pronounced in the clays and loams as a rule and less so in the sandy soils. The solubility of the phosphate originally present in the soils was also determined by percolating water through the untreated soils in the above-mentioned apparatus. It was found that the concentration of the separate fractions of percolate was practically a constant for each of the soils studied. If this concentration is reduced through any cause, such as the absorption by plants or influx of rain water, the original concentration will be again restored by more of the phosphate of the soil entering into solution. If, on the other hand, the solution is somewhat stronger than the natural concentration for that soil through any cause whatever, such as the application of a soluble phosphate, the concentration is reduced by absorption to the original strength. This is strikingly shown by the absorption results with the first few hundred cubic centimeters of phosphate solution. This constancy in the strength of the soil solution, so far as phosphate is concerned, is further shown by the removal by water of the absorbed phosphate, which has been similarly investigated. It was found that the concentration of the separate percolates decreases rapidly until the concentration is reduced approximately to that of the original soil solution. This concentration of phosphate is then maintained with much persistence, although only a fractional amount of the absorbed phosphate has been removed, thus indicating that while the absorbed phosphate is apparently rendered insoluble, it is, nevertheless, slowly but constantly going into the soil moisture and is, therefore, available to plants.

The Absorption of Potassium by Soils: OSWALD SCHREINER and G. H. FAILYER.

The absorption of potassium by soils has been studied in a manner identical with that of the phosphate. As far as investigated the potassium absorption can be represented by the equation

$$\frac{dy}{dv} = K(A - y),$$

where K is a constant, A the maximum amount of potassium the soil can absorb under the conditions of the experiment, and y the amount it has absorbed when the volume v of potassium solution has passed through the soil. The removal by water of the absorbed potassium is rapid at first but the concentration of the percolates soon reaches a constant value, although only a fractional amount of the absorbed potassium has been

removed. As far as the observations have been made, the solutions obtained by percolating a solution of potassium chloride through the soil have always been acid.

Citric Acid: F. L. KORTRIGHT.

A discussion of various unsuccessful attempts to make anhydrous citric acid according to the method of Buchner and Witter, was followed by a description of two methods used in getting the equilibrium relations between citric acid and water. The cryohydric point of the monohydrate and water, the transition point of the monohydrate to the anhydrous acid, and the transition point of one form of anhydrous acid to another, have been determined. The work is to be continued.

The Action of Metals on Complex Cyanides in Aqueous Solution: G. McP. SMITH. (By title.)

Electrolysis and Endosmosis in the Study of Rock Decomposition: A. S. CUSHMAN. (By title.)

AGRICULTURAL AND SANITARY CHEMISTRY.

Filtration and Purification of the Mississippi River Water at New Orleans: J. L. PORTER. (By title.)

A Method for the Determination of Small Amounts of Copper in Water E. B. PHELPS. (By title.)

A Trade Waste Study: Copper Salts in Irrigation Waters: W. W. SKINNER. (By title.)

The Availability of the Phosphoric Acid of the Soil: G. S. FRAPS.

The various factors which influence the amount of phosphoric acid dissolved by solvents are considered—nature of the soil phosphates, solution of soil constituents thereby exposing more phosphoric acid, fixation by the soil, and availability of the dissolved phosphoric acid. These factors appear to exclude the use of water, carbonated water, one per cent. acetic acid and $N/200$ hydrochloric acid. Soils must be divided into different classes according to the solubility of their constituents.

There is a relation between the chemically available phosphoric acid and soil deficiency in phosphoric acid, according to pot tests on a number of soils The action of the plant makes available a considerable amount of phosphoric acid. Cotton and cow peas have a higher solvent power than rice or corn, corn being very low. Though cow peas and cotton take up nearly equal quantities, the soil was deficient for cotton and not for

cow peas, showing that cotton requires more. With a given amount of chemically available plant food, the soil may be deficient for one crop and not for another with higher solvent power or lower needs.

The Effect of Climate on the Composition of Cotton Seed: G. S. FRAPS

From observations during two seasons, meal from the western part of the state appears to be much richer in nitrogen than meals from eastern Texas. The climate of the former section is semi-arid. No close relation could be traced between the rainfall and distribution of the meal. Texas meal appears, on the average, to be richer than meals from other sections.

On the Presence in Soils and Subsoils of Substances Delcterious to Plant Growth: F. K. CAMERON and B. E. LIVINGSTON. (By title.)

The Fermentation of Sugar-Cane Products: C. A. BROWNE, JR.

In the first part of the paper the writer discusses the influence of the various enzymes of the sugar cane upon the composition of the juice. The action of invertase in windrowed cane, the coloration phenomena produced by oxydases, and the physiological importance of the oxydases and catalases in the matter of protection against microorganisms are briefly presented.

The second part of the paper is devoted to a description of a few typical fermentations produced by bacteria, yeasts and molds, in cane juices, syrups and molasses. Particular attention is paid to the different compounds, dextran, mannite, cellulose, chitine, fat, etc., produced by these organisms and the influence of these upon the composition of the cane products is discussed. The writer concludes by noting the bearing which several of these compounds, such as glycerol and acetyl-methyl-carbinol, have upon the physiology of certain fermentations.

The Quantitative Estimation of Salicylic Acid: W. D. BIGELOW and W. L. DUBOIS.

This paper is an attempt to define as exactly as possible the conditions to be followed for the estimation of salicylic acid by extracting with organic solvents and comparing the color given by treating the extracted salicylic acid with ferric solutions, with solutions containing a known amount of salicylic acid. The errors most frequently made in the use of the method are pointed out and exact conditions for its use prescribed.

The results obtained on uniform samples by twelve collaborating chemists using miscellaneous methods and also using the method suggested by the writers, are given. It is demonstrated that with proper precautions results can be obtained which are reasonably accurate.

The Estimation of Hydrocyanic Acid in Cassava: C. C. MOORE. (By title.)

The Artificial Coloring Matter in Whisky: P. H. WALKER and J. H. A. SCHREIBER.

A series of tests for artificial coloring matter in whisky were described and a summary of results on a very large number of whiskies, both pure and artificially colored, discussed.

A Uniform Method for the Determination of Reducing Sugars: P. H. WALKER.

The same solutions and manipulations are used in the determination of both dextrose and invert sugar. The alkaline tartrate solution is the same as Soxhlet's; but the copper solution contains 40 grams of crystallized copper sulphate to 500 c. c. Adhering to the directions given, the values for varying amounts of dextrose and invert sugar were determined and a table prepared showing the weight of cuprous oxide, dextrose and invert sugar corresponding to each milligram of copper from 10 to 466.

The Extraction of Tanning Materials for Analysis: F. P. VEITCH and H. H. HURT. (By title.)

The Ripening of Oranges: W. D. BIGELOW and H. C. GORE.

This work is in connection with the systematic study being made by the writers, of changes that occur in fruit during its growth and ripening. The oranges increased in actual weight of total solids and sugars from the beginning to the full maturity of the fruit. At all stages of the growth of the fruit, the total sugars are divided about equally between reducing sugar and sucrose. The marc of the orange is formed very early in its history and remains constant in weight during its growth and development. The acids are also formed at an early stage and apparently increase gradually but almost imperceptibly.

Storage of the fruit at all stages of its development results in slight loss of total sugar, a marked increase of reducing sugar, and a corresponding loss of sucrose. The loss of total sugar noted above is to be explained as in the case of apples, by the consumption of reducing sugar as a result of the respiration of the fruit. The weight of marc remains practically constant and the weight of acid appears to decrease slightly on storage during the various stages of the development of the orange.

The Growth and Ripening of Persimmons: W. D. BIGELOW, H. C. GORE and B. J. HOWARD.

This paper is a partial report on the systematic study of the ripening of fruits which is being conducted by the writers. In the other fruits thus far studied, the quantity of tannin was so low as to preclude any deductions from the results obtained at various stages of their growth. The persimmon was selected largely because of its content of a relatively large amount of tannin

The weight of the pulp increases steadily during the entire period of observation and a marked increase was also noted in the case of total determined solids, sugar and marc. The sugar was found to consist almost entirely of invert sugar. The amount of sucrose is apparently almost within the limit of analytical error. The percentage of acids is also very low. During a later portion of the period of observation, the tannin was found to decrease in proportion to the increase in the weight of the marc.

The results obtained by the writers prove beyond a doubt that the tannin is not decomposed and does not actually disappear in the ripening of the fruit, but that it is converted into an insoluble form within certain specialized cells. No evidence was found of the combination of tannin with any other body in the formation of this insoluble compound. It apparently goes into insoluble form without entering into combination with any other substance.

At each date of picking, sub-samples were ripened in the laboratory as in the case of fruits previously studied by the writers. The changes occurring on storage were similar to but more rapid than those occurring in the natural ripening of the fruit. Decreases are found in the solids and sugar of the stored fruit while the weight of marc in the fruit is found to increase owing to the tannin becoming insoluble.

INDUSTRIAL CHEMISTRY.

The Cotton Oil Industry of the South: DAVID SCHWARTZ.

An interesting account of some of the methods used in purifying cotton oil, illustrated by samples of the seed, the crude and purified oil and some of the by-products. *Journ. Amer. Chem. Soc.* 28, 430.

A Comparison of Methods used in Determining Total Soluble Bitumen in Paving Material: L. AVERY. (By title.)

The Durability of Cement Plaster: E. H. S. BAILEY.

The material sold as cement plaster is made from the gypsum dirt, or "gypsite," which occurs throughout many of the states of the central west, in patches of a few score of acres, by heating in a kettle to drive off most of the water of crystallization. This material, mixed with sand, is used in the place of lime mortar for plastered walls. In addition to the calcium sulphate and water, it contains considerable calcium and magnesium carbonates, silica and oxides of iron and aluminum.

A peculiar case of disintegration of the plastered wall of a room in which there was a fan blower for ventilating and warming the building, was investigated. It was noticed that in the upper part of the room the plaster crumbled and fell. The analysis of the hard plaster and of that which had fallen showed that the fallen plaster contained about 2 per cent. of moisture, while the hard plaster contained 4.5 per cent. This would indicate

that the air which was heated by passing over steam pipes as it came into the fan room, had its capacity for absorbing moisture so much increased that it removed the water from the plaster of the wall, and so the crystals of gypsum disintegrated, and the plastering fell.

(Published in full in the *Trans. Kans. Acad. Sci.*, Vol. XX.)

Note on Sampling and Analysis of Coal: A. BEMENT.

Laid stress on the need of painstaking care in preparing samples of coal for analysis, in order to obtain reliable results.

The Examination of Writing Inks: L. S. MUNSON.

The paper gave the results of examination of a number of writing inks, made for the purpose of determining the suitability of these inks for record purposes. *Journ. Amer. Chem. Soc.* 28, 512.

Standard Samples of Iron and Steel: J. R. CAIN.

A brief statement was made with regard to standard samples of iron and steel which can now be furnished by the Bureau of Standards at Washington, and charts showing analyses of these samples by different well-known chemists were exhibited.

A Study of the Lignites of the Northwest: G. B. FRANKFORTER and E. P. HARDING. (By title.)

A Description of Improved Apparatus and of a Modification of Drehschmidt's Method for the Determination of Sulphur in Illuminating Gas: E. P. HARDING. (By title.) *Journ. Amer. Chem. Soc.* 28, 537.

Notes on Typewriter Ribbons: A. M. DOYLE. (By title.)

The American Chemist and the Gas Industry: H. B. HARROP. (By title.)

On Saturday afternoon there was an excursion across the Mississippi to see the New Orleans Acid and Fertilizer Works at Gretna. In the evening there was a general reception of the association in the Palm Garden of the St. Charles Hotel. On Sunday morning some of the chemists visited a sugar plantation some miles from the city.

On Monday morning there was another session of Section C. In the absence of C. F. Mabery his address was read by Charles E. Coates. It was entitled "The Composition of Petroleum from American Fields—Pennsylvania, Ohio, Texas, Kansas, Wyoming, Colorado, Kentucky and California." It will appear in full in the March number of the *Journal* of the society.

S. W. Parr delivered an address on "The Service Waters of a Railway System." Numerous tests to determine the loss of efficiency due to scale

having an average thickness of one-eighth inch agree in showing approximately ten per cent. increase in fuel consumption. On the basis of a total annual cost for fuel of $1,500,000, and assuming the average condition of the locomotives as fifty per cent. better than the above, the loss due to this cause aggregates $75,000. This expense is duplicated by another which would represent approximately the cost of overhauling and repairs chargeable directly to the presence of scale. We thus have a sum representing the annual interest on an investment at five per cent. of $3,000,000. This takes no account of accidents or disasters, due more or less directly to the use of poor water. At least five principal railway systems of the middle west have in operation, or are in process of installing, purification plants for the treatment of their service waters. This marks a decided advance over the condition of ten years ago, when in the same region no such plant was in existence.

Concerning treatment within the boiler itself, while this method is often applicable to stationary boilers, in the case of locomotives the construction and exigencies of service make such methods inadvisable.

The usual method of rating a water with reference to its scaling ingredients is no longer applicable. New types of water are now common, which involve entirely different properties, such as foaming and corrosion. For example, some twenty-five samples of water have been examined from Cairo to New Orleans on the lines of the Illinois Central Railway having less than fifty parts per millon of scaling matter (three grains per gallon).

Two marked characteristics are present in these waters aside from their very low amount of scaling matter. One is the high content of organic matter and the other is the presence of free sodium carbonate. In general the first type includes the waters from streams or bayous and shallow wells, while the second characteristic is present in those samples from wells from 100 to 800 feet in depth, one well, indeed, (at Hamm, La.) having a depth of 2,100 feet.

With these waters two problems, other than that of scaling, present themselves—first, corrosion, and second, foaming. A number of experiments were detailed, indicating the conditions which promote the corrosion of iron. As nearly as possible, the conditions existing inside a boiler were reproduced, using an autoclave, within which were placed vessels containing samples of iron submerged in various solutions and the whole maintained at 100 pounds steam pressure.

Briefly stated, the results showed active corrosion to occur in presence of organic material, especially the tannins, also when oxygen or carbon dioxide was generated with the steam, as well as with the well-known conditions where salts of calcium or magnesium nitrate or chloride were present. These results readily explain the cases of corrosion met with in these southern waters. The other difficulty, that of foaming, occurs in general when the alkalies of whatever sort are present to the extent of fifty grains and over per gallon. But this difficulty is greatly accentuated

by the presence of free sodium carbonate and for the reason, as seems evident from experience, that the finely divided precipitate which results in conjunction with the free alkali, are the chief elements in the promotion of foaming.

Along the same line is the explanation for foaming when the use of a water containing free alkali is followed by the addition of a turbid water, like that of the Mississippi River.

The very extended use for sanitary reasons in the regions farther north, of deep well waters, has revealed the fact that this type of water having from three to fifteen grains per gallon of free sodium carbonate is distributed over very wide areas and brings into prominence their behavior when applied to locomotive use.

"It is thus seen that the problems connected with railway service are altogether different from those that attend the use of stationary boilers. They involve no very profound chemical principles and perhaps on that account have received little attention, but the industrial importance of the matter is very great and if for no other reason, the subject may be worth noting here as an illustration of an improved and more healthy state of affairs in the industrial world, which shows itself in giving attention to wastes and greater care in small economies. When we acquire, and there are many indications that we are attempting, the habit of looking after all possible wastes and losses from principle, the profits are more sure to look out for themselves."

This will appear in full in the *Journal of the American Chemical Society.*

W. D. Bancroft delivered an address on 'The van't Hoff-Raoult Formula."

The apparent osmotic pressure depends on the molecular weight of the solute and on the heat of dilution. If the latter is zero, as at infinite dilution, the apparent and the theoretical osmotic pressures coincide. If the addition of one liter of solvent to one liter of a normal solution causes a heat effect of one gram calorie, the apparent molecular weight of the solute may be ten per cent. in error at 0°. In all cases in which there is a marked evolution of heat on diluting the solution, the apparent molecular weight will decrease with increasing concentration. Instances of this are sodium in mercury, resorcinol in alcohol, sulphuric acid, caustic potash, or cupric chloride in water. The abnormal behavior of sodium chloride in concentrated aqueous solution is due to another cause. The paper will be published in the *Journal of Physical Chemistry.*

After this the meetings of the sections were resumed.

BIOLOGICAL CHEMISTRY.

Investigations on Salts of Casein: J. H. LONG.

The Relation of Carbon Dioxide Excretion to Body Weight: G. O. HIGLEY.

The Relation between Barometric Pressure and Carbon Dioxide: G. O. HIGLEY.

The Separation of Preoteoses and Peptones from the Simpler Amido Bodies: W. D. BIGELOW and F. C. COOK.

The paper gives the results of the examination of several methods that have been employed for the purpose mentioned. It was found that the Sjerining method, employing a solution of tannin and sodium chloride, gave the most satisfactory results, but much better results could be secured by increasing the amount of both tannin and sodium chloride in the reagent. The maximum results were obtained when the proteid bodies were precipitated in a solution containing 15 grams of sodium chloride and 5 grams of tannin per 100 c. c.

The claim of earlier writers that an excess of tannin has a solvent effect on the precipitate was not confirmed, although solutions containing 7.5 grams of tannin per 100 c. c. were employed. It was found that when the precipitation and filtration were conducted at from 12° to 15° C. much more satisfactory results were obtained, and clear filtrations were much more readily secured than in the case of room temperature.

Attention is called to the fact that the precipitating power of various preparations of tannin is not quite uniform, and it is suggested that a uniform tannin be used in the prosecution of any particular investigation. It is also essential that correction be made for the nitrogen content of the tannin employed as reagent and that blanks be run with the reagent in order to determine the amount of nitrogen precipitated from the tannin of the tannin-salt solution. Attention is called to the fact that tannin undergoes fermentation and loses to a large extent its power of precipitating proteids. The reagent should, therefore, be kept in a cool place and for not more than a few days at a time.

The effect on a number of amido bodies of a solution containing 15 grams of chloride and 5 grams of tannin was also studied. No precipitation was obtained with glycocoll, alanine, glutamic acid, aspartic acid, allantoin, asparagine, betaine, creatinine, glutamine, guanine, xanthine, hypoxanthine, leucine, diphenylamine, acetamide and sarcosine. Precipitates were obtained with creatine, trimethylamine and phenylenediamine. It is probable that phenylenediamine and trimethylamine do not occur in meat, but the latter is found in considerable quantity in fish and in beet root. The error occasioned by the partial precipitation of creatine may be corrected by determining creatine, before and after the precipitation with the tannin-salt solution, by means of Folin's method for the estimation of creatine in urine.

The Influence of Salicylic Acid on the Excretion of Urea and Uric Acid, and a Comparison of the Mörner-Sjqvöst and Braunstein Methods for Determining Urea: F. C. WEBER.

The Influence exerted by Chemical and Physical Agents on the Virulence and Speed of Development of Mouse Tumors: G. H. CLOWES.

The Effect of the Rays of Radium on Plants: C. S. GAGER.

Experiments of the writer show that the rays of radium and of other radioactive substances, such as radio-tellurium and thorium, act as a stimulus to the various life processes of plants. There are doubtless minimum, optimum and maximum points, depending upon the strength of the radium preparation, the distance and time of exposure, and the intervention of substances more or less opaque to the various rays. The quantitative determination of these points has not yet been made.

When seeds, either dry, or during the imbibition of water, are exposed to radium bromide of 1,500,000 and of 10,000 activity in a sealed glass tube, for twelve hours or more, germination and subsequent growth are retarded. If the same radium preparations are inserted in the soil in pots containing germinating seeds, there is a decided acceleration of germination and growth. In such plants there is a marked increase in the number and length of root-hairs.

When plants are grown under a bell-jar containing decaying radium emanation drawn from a hollow tube lined with Lieber's radium coating, germination and growth are either retarded, completely inhibited, or accelerated, according to the amount of the emanation supplied, and the duration and distance of exposure.

When the stimulation is of such intensity as to accelerate growth, the rate of growth at first increases, and then gradually decreases until it falls below that of the control plants.

Marked antaomical changes are effected by exposure to the rays, the cross-section of the stem of a radiated plant, for example, showing no signs of cambium.

Respiration and alcoholic fermentation may be accelerated. By strong exposure chloroplasts in the cell take up a position similar to that assumed under intense sunlight, and eventually the radiated portion becomes etiolated.

It is hoped to be able still further to study the effect of the rays on cell activities by means of radioactive microscopic slides now being prepared at the writer's suggestion by Mr. Hugo Lieber, of New York. Grateful acknowledgment is here made of Mr. Lieber's liberality in supplying some $2,000 worth of radium preparations, without which these experiments would not have been possible.

Experiments to Determine the Effects of Radium on Minute Animals: L. HUSSAKOF.

These experiments were intended primarily to show the influence, if any, of radium rays on the protoplasm of *Amœba proteus*. Other microorganisms (*Vorticella*, *Paramœcium*, etc.) were also subjects of experiment. Radium bromide preparations of 600, 1,000, 10,000 and 1,500,000 activity (in thin glass tubes) were used, and several celluloid rods covered with Lieber's "radium coatings" of 10,000 to 25,000 activity were also employed. The

radium container was held in the water within from 1 mm. to 3 mm. of the organism under observation.

Under these conditions no visible effects were produced, by even the strongest radium preparations, during periods of observation of about an hour. The water surrounding the animal may have prevented radiant effects.

The Effects of Intravenous Injection of Radium Bromide in Dogs: R. B. OPITZ and G. M. MEYER.

The paper dealt principally with effects on circulation and respiration. Light ether narcosis was employed. With radium bromide of 240 and 1,000 activity there was a marked rise in blood pressure, caused by a general vaso-constriction, followed by a marked decrease in the frequency of the heart, causing fall in pressure. These effects are the same as obtained with pure barium bromide. With radium bromide of 10,000 activity there was a much less noticeable initial vaso-constriction, and the short forcible contractions of the heart which caused the pressure to rise suddenly in jerks beyond any ordinary level, are now succeeded by slow pulsations. The blood pressure thus remained below normal. A moderate decrease in the frequency and depth of respiration was noted.

The Radioactivity of the Organs of Dogs after Administration of Radium Bromide: G. M. MEYER.

The organs were incinerated in a porcelain dish and tested for radioactivity by means of a quadrant electrometer. With injections of radium bromide of 240 activity only the blood was radioactive. If injections are made for several days and time is given for the radium to be eliminated, the blood is no longer active, though the kidneys, urine and feces are. With radium of 10,000 activity most of the organs were radioactive. There was considerable salivation and the saliva was active. Though the radium is excreted through the kidneys and intestines, the latter do not become radioactive.

Experiments to Determine the Influence of Radium Bromide on Protein Metabolism in Dogs: W. N. BERG and W. H. WELKER.

The experiments are being carried out on dogs in nitrogenous equilibrium. Radium bromide preparations of 240, 1,000 and 10,000 activity have been employed. One animal (6.6 kilos) has been fed 1.100 gms. 240 activity, 0.250 gm. 1,000 activity, and 0.125 gm. 10,000 activity in small amounts daily (during twelve days), without causing any gross symptoms, except diarrhœa during the period of administration of the preparation of 240 activity with its large content of barium. Proteid metabolism did not appear to be materially affected. Total sulphate (SO_4) in the urine was markedly increased, especially during the period following the administration of the preparation of highest activity, and when diarrhœa as well as constipation was entirely absent.

In control experiments with barium bromide, much larger quantities *per os* (as much as 0.5 gm. daily to a dog weighing only 4.5 kilos) were without any gross symptoms whatever. In the case of barium, also, proteid metabolism was practically unaffected by the quantities used. The quantity of total sulphate in the urine, unlike the result with radium, appeared to be unaffected by the barium bromide.

Injection (subcutaneous) experiments have also yielded negative results.

The Cutaneous Excretion of Nitrogenous Material: F. G. BENEDICT.

During rest, there is an average excretion in the perspiration of 0.071 gram of nitrogen per day. That it is in large measure urea or ammonium compounds is highly probable, though the presence of soluble proteids is not at all impossible. With hard muscular labor the amount of nitrogen excreted may amount to 0.22 gram in one hour. The amount excreted is roughly proportional to the work done. In accurate metabolism experiments these amounts should be taken into account.

The Incapacity of the Date Endosperm for Self-digestion: R. H. POND.

The conclusion drawn from a number of experiments conducted under varying conditions is that the endosperm of *Phœnix dactylifera* is incapable of autodigestion.

The Influence of Aluminium Compounds on the Growth of Lupin Seedlings: H. D. HOUSE and WM. J. GIES.

Aluminium sulphate, nitrate and chloride, aluminium sodium chloride and potassium and ammonium alums were used. In nearly all cases little or no effect was produced by solutions of 1/65,536-molecular concentration, but at greater concentrations growth was markedly inhibited. At greater dilutions there was usually a stimulation to growth.

Studies on the Banana: L. B. MENDEL and E. M. BAILEY.

The behavior of green bananas subjected to various abnormal atmospheres and to inert surface coatings has been studied with reference to the effect on ripening processes. Chemically considered, the phenomena of normal ripening is essentially an almost complete conversion of a large store of starch into soluble carbohydrate, attended by a decrease in the total carbohydrate. Failure to effect this chemical change, together with an absence of characteristic color changes of the peel, is taken as evidence of non-ripening. Bananas placed in atmospheres (hydrogen, carbon dioxide, illuminating gas) in which available oxygen was lacking, failed to produce notable amounts of soluble carbohydrate, or to show any considerable decrease in total carbohydrate, the same being true when they were enveloped by an inert surface coating such as paraffin. Furthermore, the respiratory products of the fruit appeared to effect an inhibitory action

upon its healthy development and ripening. Two experiments with an atmosphere of oxygen indicated that this gas somewhat accelerated ripening processes. These studies were preliminary to an attempt to detect and isolate enzymatic agencies which may be present. Autolyses with the green pulp, or the green pulp and scrapings of the inner surfaces of the peel, or of the partially ripened pulp, carried out with toluene water under varied conditions, have yielded negative results. The investigation is being extended in various directions.

The action of Eosin upon Tetanus Toxin and in Tetanus: S. FLEXNER and H. NOGUCHI.

1. Eosin and certain other aniline dyes have the power of destroying *in vitro* the hemolytic property of tetanus toxin.

2. Eosin when used in sufficient quantity destroys tetano-spasmin *in vitro*.

3. Simultaneous injection of tetanus toxin and eosin into rats delays or prevents the appearance of the symptoms of tetanus. When the symptoms appear they progress more slowly than in control animals.

4. Scores of tetanus bacilli when introduced in threads into rats together with immediate eosin injections, do not produce tetanus. The treatment of animals with eosin, after the first appearance of the tetanic symptoms following spore-infection, may prevent the further developments of the symptoms of tetanus. Eosin injections into the same locality as spore inoculations are the most effective, but injection into other parts of the body delays or modifies the tetanus process.

5. Rats are more resistant to tetanus than guinea-pigs, and hence are more easily protected by eosin from tetanus poison. But in guinea-pigs the fatal issue can be delayed by eosin.

The Action of Eosin and Erythrosin upon Snake Venom: H. NOGUCHI.

1. The hemolytic principles of venom react differently to eosin, depending upon their native liabilities. The hemolysin of *Crotalus* venom suffers most; that of *Daboia* next, while that of *Cobra* is most resistant.

2. The toxicity of different venoms is more or less diminished by eosin in the light. *Cobra* is least affected; *Crotalus* and *Daboia* venoms are most affected. *Crotalus* venom loses its toxicity chiefly by destruction of hemorrhagin; and *Daboia* by destruction of coagulin.

3. Neurotoxin is little or not at all affected by eosin or erythrosin.

4. There is a parallel between the susceptibility of the toxic principles of snake venom to fluorescent anilines and their susceptibility to other injurious influences. Hemorrhagin and coagulin are less stable at high temperatures than neurotoxin, and more easily destroyed by acids than neurotoxin and hematoxin.

On the Decomposition of Purine Bodies by Animal Tissues: P. A. LEVENE and W. A. BEATTY.

The authors aimed in this work to study the products of decomposition of purine bodies in the tissues. Jones, Schittelhelm and Levene have observed that amino-purines are transformed into oxypurines. It is well known that purine bodies undergo complete destruction in the course of tissue autolysis.

The authors have studied the conditions most favorable for the process of purine decomposition by animal tissues and have endeavored to ascertain the general nature of the substances formed during the process. It was found that the presence of 0.5 per cent. of sodium carbonate in mixtures of spleen pulp facilitated the decomposition of purine bodies to such an extent that even uric acid is broken up by that tissue. It was also noticed that the decomposition products were non-basic in nature, for they were not precipitated by phosphotungstic acid. On decomposition of uric acid by tissue extracts, formation of ammonia could not be detected.

On the Biological Relationship of Nucleoproteid, Amyloid and Mucoid: P. A. LEVENE and JOHN A. MANDEL.

The authors endeavored to ascertain the nature of the carbohydrate groups in the proteid molecule. It was found that by heating nucleoproteid on a water bath with a 5 per cent. solution of sulphuric acid, a product could be obtained that had the properties of a polysaccharide or of a glucosoid and which contained in its molecule a small proportion of sulphuric acid (S = 0.5 per cent.). On treating nucleo-proteids with alkali, substances were obtained containing a much greater proportion of sulphuric acid (S = 3.5 per cent.; N = 8.8 per cent.). The substances thus obtained were found to possess the properties of glycothionic acids containing small quantities of nucleic acid.

Glycothionic acid has hitherto been recognized as a constituent of mucoid and amyloid. The results of this investigation place the three groups of substances in genetic relationship.

Contributions to our Knowledge of the Chemistry of Carbamates: J. J. R. MACLEOD and H. D. HASKINS.

A description of a method for the quantitative determination of carbamates, even in the presence of soluble carbonates and ammonium salts. Also a study of the formation and stability of carbamates under these conditions.

The Effect of Alcohol on the Secretion of Bile: WM. SALANT.

With dogs there is a diminished secretion of bile following intravenous injection of alcohol. There was also a decrease in the organic and inorganic constituents, though little change in their relative amounts. When alcohol was injected into the stomach there was from 30 to 365 per cent

increase in the amount of bile. The solid constituents were also markedly increased, in one case as much as 132 per cent. The increase in inorganic matter did not keep pace with the organic matter excreted.

The Relation between the Concentration of Hydroxyl Ions and the Rate of Tryptic Digestion in Dilute Solutions of Various Bases: W. N. BERG.

Experiments were made in which the speed of tryptic digestion, in solutions of various bases, which contained the same concentration of hydroxyl ions, was measured.

The results seem to show that the speed of tryptic digestion is a function of the concentration of hydroxyl ions; but the accompanying action and non-ionized molecules also affect the speed. In the solutions of the bases used the speed was fairly uniform when the concentration of hydroxy ions was the same.

On the Decomposition of Thymus Nucleic Acid by an Extract of Pig's Spleen: WALTER JONES.

1. Fresh dog's spleen converts guanine into uric acid, the ferments of this spleen not being different from those of ox spleen.

2. By the action of an aqueous extract of pig's spleen on thymus nucleic acid guanine is produced in considerable quantity; xanthine, not at all.

Concerning Peptone: L. B. STOOKEY.

This paper is a continuation of a study of peptone carried out in the laboratory of Professor Hoffmeister. One of the fractions, designated as "1 B Benzoyl Chloride γ" has been investigated further. This substance gives the following reactions: Biuret, Molisch and an extremely faint xanthoproteic. Hopkins and Millon are negative. Sulphur is not present. Five grams were boiled with five per cent sulphuric acid until the Biuret reaction disappeared. A residue remained. This residue gave the Molisch reaction more intensely than the original substance. It is not impossible that the residue was glucosamine benzoyl chloride. The filtrate was examined in the usual manner. Neither arginine nor histidine could be detected. Lysine was present and was identified as the picrate. Neither aspartic nor glutamic acid could be found. Alanine was isolated and identified as a copper salt. On account of the small amount of substance examined, these findings can not be looked upon as conclusive; yet the fact that a condensation product of two benzoyls, one lysine, one glucosamine and one alanine would have the following composition: C 57.80 per cent., N 9.30 per cent., H 6.31 per cent., O 26.57 per cent., while this fraction gave as follows: C 58.68 per cent., N 8.96 per cent., H 5.88 per cent., O 26.48 per cent., may be regarded as suggestive and might indicate a molecular formula of $C_{29}H_{38}N_4O_{10}$.

On the Composition and Toxic Properties of Ibervillea Sonorae: JULIA A. EMERSON and W. H. WELKER.

The Comparative Chemical Composition of the Hair of Different Races: P. B. HAWK and T. A. RUTHERFORD.

On the Chemical Composition of the Nasal Mucous Membrane: B. RUSSELL and WM. J. GIES.

The following percentage data on general composition represent average results of analyses of tissue from many oxen:

Portion.	Water.	Solids.	Organic Matter,	Inorganic Matter.
Anterior	76.69	23.31	22.34	0.97
Median	78.68	21.34	20.34	1.00
Posterior	79.61	20.39	19.38	1.01
Longitudinal sections selected at random	77.64	22.36	21.49	0.87
Transverse sections selected at random	77.74	22.26	21.46	0.80

The quantity of ether-soluble material is equal to about 8 per cent. of the solid matter. Reducing substance was absent from the aqueous extracts. Neither proteolytic nor amylolytic enzymes have thus far been detected. Autolytic changes will be investigated.

Much of the proteid in the tissue dissolves in water and salt solutions. Successive extractions of the fresh tissue in water, 5 per cent. sodium chloride and 0.5 per cent. sodium carbonate yielded solutions from which the following quantities of pure proteid (in terms of percentage of fresh tissue) were precipitated: water, 4 per cent.; sodium chloride, 2 per cent.; sodium carbonate, 0.5 per cent. A collagenous residue, amounting to 10.5 per cent. remained.

Conspicuous among the soluble proteids present in the extracts is an acid-precipitable material, equal to about 2 per cent. of the fresh tissue. Its properties have not yet been distinguished in detail. It appears to be nucleoproteid or a mixture containing nucleoproteid in large proportion. It does not appear to be coagulable. Preliminary tests have failed to show the presence of mucoid in the extracts.

Nearly ten per cent. of the fresh tissue is indigestable in artificial pancreatic juice, and gelatin is readily obtained from this residue. Only about one per cent. of the fresh tissue remains undissolved in artificial gastric juice. This residue contains nuclein.

ORGANIC AND INORGANIC CHEMISTRY.

Some Hydrocarbons in Louisiana Petroleum: C. E. COATES.

In the investigation of the petroleum from Jennings, Louisiana, the latter fractions were found to consist of the compounds C_8H_{14}, C_9H_{16},

$C_{10}H_{18}$, $C_{11}H_{20}$, $C_{12}H_{22}$, etc., all of the series C_nH_{2n-2}. The petroleum is of an asphaltic base and the substances $C_{12}H_{22}$, $C_{13}H_{24}$, etc., seem to be identical with those previously obtained from asphaltum and asphaltic oils. These have been assumed to be derivatives of dihexahydrodiphenyl because $C_{12}H_{22}$ was the lowest known member. The occurrence of members still lower would seem to make this theory improbable. The series is, therefore, of a constitution as yet undetermined. *Journ. Amer. Chem. Soc.*, 28, 304.

Diphenylamine Compounds of Chloral: A. S. WHEELER. (By title.)

The Chlor-hydrochlorides of Pinene and Firpene: G. B. FRANKFORTER and F. G. FRARY. (By title.)

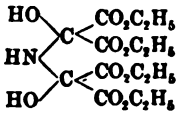
Aluminum Phenolate: A. N. COOK. (By title.)

The Methoxy- and Ethoxydibromphenanthrenes and Some of their Isomers: G. B. FRANKFORTER and C. R. CRESSY. (By title.)

Ethyl Oxomalonate and its Behavior toward Ammonia: R. S. CURTISS.

Ethyl oxomalonate has always been a costly substance to make in any considerable quantity. It can be readily be prepared with a large yield (95 per cent.) by the action of nitrous anhydride on ethyl malonate at a low temperature. The product is purified by vacuum distillation.

Dry ammonia gas reacts strongly with ethyl oxomalonate, or with its hydrated form, ethyl dioxymalonate. Under certain exact conditions it produces a white crystalline substance, dioxyiminodimalonic ester,



This body is very unstable, and dissociates into ammonia and ethyl dioxymalonate if allowed to stand in moist air. The same change occurs rapidly if it is placed in water.

Note on the Action of Hot Cupric Oxide on Sulphuric Ether: J. P. ATKINSON and H. DURAND. (By title.)

We noticed while examining medicinal prescriptions, containing ether, for methyl (wood) alcohol, that we invariably obtained a strong formaldehyde reaction, both by odor, Hehner's test, and the morphine-sulphuric acid test.

Believing that it was impossible that all the prescriptions could be adulterated, we tested samples of pure ether separately, and found that this compound would yield formaldehyde upon oxidation with hot copper oxide. We have since tested many samples of ether to undoubted purity, manufactured by the best known chemical houses, and have always obtained the same result.

The reaction can be written as follows:

$$\begin{matrix} C_2H_5 \\ C_2H_5 \end{matrix} > O + 4CuO = 4HCHO + Cu + H_2O.$$

In Watt's "Dictionary of Chemistry" platinum black is mentioned as a reagent which produces this reaction, but since a hot copper spiral is usually used in the qualitative method of determining the presence of methyl alcohol, we call attention to this reaction.

The Use of Porcelain Dishes in Silicate Analyses: F. L. KORTRIGHT.

Platinum dishes are usually preferred for evaporations in silicate analyses, on the assumption that porcelain dishes are liable to be corroded and thus an excess of silica obtained. In a few cases where a loss of silica is assumed to occur through the use of porcelain dishes, the statement is made that the loss occurs through not being able to see the silica adhering to the white surface of the porcelain.

It has now been found that the difficulty in seeing the adhering silica is not the chief cause of loss when porcelain dishes are used, but that a portion of the silica adheres so tightly to the dish that it is not possible to remove it by any ordinary methods. In one case where 17.93 per cent of silica was obtained by using a platinum dish, only 17.09 per cent. of silica was obtained when a porcelain dish was used. By suitable treatment with ammonia, however, the silica adhering to the porcelain dish was separated, and the total silica, when using a porcelain dish, was then found to be 17.97 per cent. Other determinations of silica in porcelain were reported, and although the variations from the values obtained in platinum were not so striking, the results were all low when ordinary methods were employed for removing the silica from the dish.

An Occurrence of Native Sulphur in Oconee County, Ga.: H. C. WHITE. (By title.)

Report on the Water of Death Gulch, Yellowstone National Park: G. B. FRANKFORTER. (By title.)

The Determination of Silica: N. KNIGHT. (By title.)

On the Occurrence of Helium in Natural Gas: H. P. CADY and D. F McFARLANE. (Read by E. H. S. Bailey.)

PHYSICAL CHEMISTRY.

The Transition Temperature of Sodium Bromide. A New Fixed Point in the Thermometric Scale: T. W. RICHARDS and R. C. WELLS (Read by the chairman.)

The results of this paper may be summed up in the following sentences:

1. Pure sodic bromide is not to be obtained by recrystallizing the ordinary commercial samples, but must be made from pure bromine and pure sodic carbonate.

2. Prepared in this way, our salt upon analysis was found to correspond very closely with the new atomic weight of sodium, 23.008, if silver be taken as 107.93, and bromine, 79.955, therefore, it was presumably pure.

3. The less pure material on successive recrystallization gave in every case a slightly rising transition temperature as the crystallization proceeded. Only the purest material melted at a perfectly constant point, therefore, constancy of melting point is an indication of purity; but it is safer to analyze the salt as well.

4. When all precautions are taken it is possible to duplicate the results for the transition temperature with samples of salt prepared in different ways and at different times without great difficulty; a value within .01 of the truth may be easily obtained and further precautions make a much greater accuracy possible. Therefore, the point is one suitable to use in the calibration of thermometers, although its determination requires more chemical skill than that involving sodic sulphate.

5. The actual value of the transition temperature on the international hydrogen scale is 50.674°.

(To be published in the *Proceedings of the American Academy* and the *Journal* of the society.)

A Method of Standardizing Thermometers Below Zero: T. W. RICHARDS and F. G. JACKSON. (Read by the chairman.)

This paper describes a simple method of calibrating thermometers at temperatures below the freezing point of water, by using as a standard of comparison the depressions of the freezing point caused by given additions of hydrochloric acid. Data, based upon a very accurate thermometer standardized at the Bureau International at Sevrès, are given for the construction of a curve enabling direct comparisons of a thermometer to be made with a minimum of labor. The manipulation consists simply in stirring hydrochloric acid into a mixture of pure ice and water until the desired point on the doubtful thermometer is reached. Analysis of the solution then gives, by reference to the curve, the true freezing point; and the difference between this value and that read on the thermometer gives the error of the thermometer. The method is shown to be both practically and theoretically satisfactory. This paper is preliminary in nature, and does not pretend to give final values, because only a single standardized thermometer was used.

(To be published in the *Proceedings of the American Academy.*)

The Heat of Dilution of Resorcinol in Alcoholic Solutions: S. T. LINCOLN.

The Solubility of Gypsum in Solutions of Ammonium Sulphate: J. M. BELL and W. C. TABER. *Journ. Phys. Chem.* X, 140.

The solubility of gypsum in ammonium sulphate solution has been investigated by Droeze, Cohn and Sullivan at temperatures not exceeding 25° C. At 50° C. the authors have found that the compositions of solutions lie on three curves, one representing solutions in equilibrium with gypsum, one representing solutions in equilibrium with ammonium sulphate, and the third representing solutions in equilibrium with a double salt which was found to have the composition $CaSO_4 \cdot (NH_4)_2SO_4 \cdot 2H_2O$.

The Solubility of Gypsum in Solutions of Magnesium Sulphate: F. K. CAMERON and J. M. BELL.

Owing to the difficulties in determining small amounts of calcium in the presence of large amounts of magnesium the authors have adopted the following method for the determination of the solubility of gypsum in solutions of magnesium sulphate. Weighed plates of selenite were placed in known amounts of solutions of magnesium sulphate of concentrations which had been determined previously. The loss in weight of the plates is a measure of the solubility in these solutions. The solubility curve at 25° is rather remarkable, as it has both a minimum point and a maximum point. At low concentrations of magnesium sulphate the solubility of gypsum decreases as the content of magnesium increases, but above 14 grams $MgSO_4$ per liter the solubility of gypsum increases up to a concentration of about 100 grams $MgSO_4$ per liter. From that point the solubility decreases again. The solution in equilibrium with both solid phases contains 355 grams $MgSO_4$ and 0.50 gram $CaSO_4$ per liter.

Two tentative explanations are offered to account for the peculiar shape of the curve. The change of density of the solvent due to the presence of solutes (concerning which change practically nothing is known) may account for the peculiar curve. The second explanation is that the magnesium ion, the sulph-ion and the undissociated $MgSO_4$, the proportions of which change with the concentration, have altogether different effects upon the solubility of gypsum. *J. Phys. Chem.* X, 210.

On Monday afternoon the society visited Audubon Park and the sugar experiment station, where opportunity was given to witness all the processes of sugar-making, from the growing cane to finished sugar.

On Tuesday morning a special train was chartered on the Louisiana Southern Railroad to take the party to the Braithwaite Sugar Factory where about one thousand tons of cane are worked up per week. In the afternoon a sugar refinery and the National Rice Mills were visited.

CHAS. L. PARSONS,
Secretary of Section C.

SECTION D.

Mechanical Science and Engineering.

OFFICERS OF SECTION D.

Vice-President and Chairman of the Section.

F. W. McNAIR.

Secretary.

WM. T. MAGRUDER, Columbus, Ohio.

Member of Council.

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Member of General Committee.

G. W. BISSELL.

Press Secretary.

WM. T. MAGRUDER.

ADDRESS

BY

D. S. JACOBUS,

VICE-PRESIDENT AND CHAIRMAN OF SECTION D FOR 1905.

INVESTIGATIONS AND COMMERCIAL TESTS IN CONNECTION WITH THE WORK OF AN ENGINEERING COLLEGE.

In any school it is necessary, in securing the best efficiency in instruction, that the professors shall be able to speak with authority on the subjects which they teach. In technical schools those who teach the practical engineering subjects can not speak with authority unless they have had practical experience. Investigations and commercial tests may serve to give them this practical experience, and the question naturally arises—is it a good policy for professors to conduct such work in connection with their regular college duties?

Let us consider the various ways in which a professor in an engineering school may acquire the practical experience which is necessary in his work.

First, he may be called to a professorship from the practical field.

Second, after teaching for a time and finding how necessary a practical experience is in his work, he may turn to the practical field, and then return to teaching.

Third, he may undertake practical work in connection with his college duties, and gain his experience in this way.

Each method possesses its own advantages and disadvantages. Starting with the first, it must be admitted that many of our best instructors have entered the teaching line after they have had experience in the practical field. Such a man

has an advantage in being able to make use of this experience immediately, when he starts in at his teaching work. There is a disadvantage, however, in the fact that should he have secured a mature experience in the practical field, he will necessarily be no longer a young man, and it may be hard for him to teach and to properly adapt himself to the theoretical part of his course. Again, if he has made a marked success in the practical field his financial reward may be so great that he would have to make a considerable sacrifice in this respect should he turn to teaching. There are some men who, from their love of teaching or through the influence of high ideals, have been willing to do this, but these are few, and the college obtaining such a man is, indeed, fortunate. This side of the problem is a serious one from the standpoint of the college, because the man it would like to get may be beyond its reach, and those available may have made only a partial success in the practical field.

If a young man with a limited practical experience becomes a teacher, this will be of assistance to him, but not as much as the more mature experience of an older man. In either case, a professor should not assume that, having had a practical experience, this is all-sufficient, and that it simply rests with him to base his teaching on the results of this experience. To keep in touch with what is going on it will be necessary for him to spend much of his time in studying what is being done in the outside field, or to resort to the third method, and do practical work in connection with his regular college duties. If he does not do this he will soon fall behind-hand, and the efficiency of his instruction will be decreased.

The advantages of the second system of securing a practical experience, where the professor leaves the teaching field, takes up outside work, and then returns to teaching, are that during his practical career he will be very much alive to the points he should look into, and, furthermore, if he returns to teaching he will possess the advantage of having experience both as a teacher and as a practical engineer. We all know that there is much more to the right sort of teaching than a thorough knowledge of the subject to be taught, and that the old saying "a man must be born a teacher" contains much truth. It is,

indeed, just as necessary that a successful teacher shall have the right qualities as an instructor, as that he shall possess the necessary knowledge. The main disadvantage of the second method is that if a professor makes a success in the practical field his financial reward may, as already stated, be so great that it will be hard to tempt him back to teaching.

We will now take up the third method, where a professor obtains his practical experience by conducting outside work in connection with his college duties. In the first place, let us consider the subject from the standpoint of the man himself. If he is an enthusiast, this method of obtaining an experience will lead to harder work on his part than either of the others. This assumes that his college work is not neglected, and that by doing the outside work he is making his course at all times better and more useful to the students. In this connection something may be said about the methods of teaching in engineering schools. I believe that the one proper way to teach an engineering subject is for the professor at the head of a department to get down to hard work with his students, and to know each of them so well that he is thoroughly acquainted with their personal characteristics. Certain parts of his course can be turned over to assistants, but the moment he avails himself of the assistance of others to such an extent that he is no longer in close relationship with the students, his efficiency in instruction will be decreased. In other words, the professor must exert himself to the utmost to secure the best results with his students, and when this is done, there is no harder way to gain a practical experience than by the undertaking of outside work; and if the professor is an enthusiast there is often much danger of his breaking down under the strain. On the other hand, if he manages to secure an experience which will give him the reputation of being an authority in his field, he usually will make the best sort of a teacher, and be a credit to the college with which he is connected. All this assumes that the classes are not too large—and I am a thorough believer in comparatively small classes—and also that his teaching roster is so arranged that he will have time available for the outside work. It would certainly be unfair to expect a professor to gain a reputation in either research or commercial work if his

time is so fully occupied with class work that, with the exception of his summer vacation, there would be little time except the evenings in which to do such work. One must not be misled, however, in thinking that if some definite time, say a certain number of days each week, is set aside for the purpose, that this will make it an easy matter for a professor to undertake practical work. If he is an enthusiast he will find that he must often stand up to his task night after night, and unless he is willing to do this it is folly for him to undertake to gain an experience in the way indicated.

From the standpoint of the college, allowing the professors to undertake any and every sort of work to gain a practical experience is a most dangerous one. There is a tendency in many cases to do work for which the professor has not the proper capacity, and in this way he may throw discredit on his college. There is nothing that will so greatly damage the reputation of a professor, and in turn of the college with which he is connected, as the issuance of a report which shows him to be incapable of properly coping with the subject, or which is in the nature of an advertisement for this or that machine or commodity. The outside work undertaken by a professor should be that of a scientific or strictly engineering type. In much of the work his reports simply recite facts deduced from various test data, whereas in others it is necessary for him to render an opinion. There is danger in arriving at false deductions as well as in advancing false opinions, and unless the professor can be thoroughly trusted, it would be better to cut out all such work. There is also a great danger of a professor bringing disrepute to his college if he is careless in his testimony as an expert. If his testimony in this line is wilfully misleading, or if he depart a hairsbreadth from truth, it were well that he had never been given the chance of lowering the dignity of his profession. On the other hand, a strictly honest and able man may bring credit to his college by his success and acknowledged fairness in this same line of work.

The advantage to a college in having its professors do research and outside work is that what reflects to the credit of the professor will reflect to the credit of the college. Furthermore, the college will be looked to as a source from which

an unbiased opinion can be obtained, and in maintaining this standard it will be fulfilling a high and useful mission. The results of the investigations may be made the subjects of scientific papers to be read before the various societies, and any reputation that a professor gains in this way will benefit his college. Furthermore, the college gains through the acquisition of much of the apparatus used in the investigations. The college will also be the gainer financially, because if a professor is allowed to do professional work, what he receives from this source really pays a part of his salary. Aside from a financial gain in this way, however, it is a question whether a college should endeavor to secure any great financial return from such work. There should be enough earned directly by the college to pay for the use of the apparatus, the wear and tear, etc., and for providing a fund for the purchase of new apparatus for the work; but aside from this, it is my opinion that the college need not be the financial gainer. I say this because if too much stress is laid on the money-getting side of the problem it will not be possible to do the right sort of work, and to do it in a proper way. A party may be willing to pay a large sum for an investigation of a project where it is evident that no matter what results are obtained, they will not add to the scientific knowledge of those undertaking the work, and where it is also evident that all that is wanted is the name of the professor, and that of the college with which he is connected for promoting the project. Such work should never be undertaken, no matter what the commercial returns may be. On the other hand, a poor inventor may desire to have a test made on some machine which he has constructed and in which there appears to be a possibility of development, and such a test might well be undertaken although it may give no financial return. The proper sort of commercial work to do in connection with a college is that of a research character, or where scientific results are obtained. It will be found that when the work is limited to this sort that it often cuts off much that is of a less desirable nature, but in which the financial returns would be greater.

In all that has been said so far it is assumed that it is necessary for certain professors to have an experience in the out-

side field. I do not think any one will question this. One is apt to get into a rut in teaching and to have his mental horizon narrowed so that he can not perceive his own faults, and there is no better way of expanding this horizon than to be a co-worker with practical men. The main advantage that a practical teacher has over one who is purely theoretical is that he can make his course interesting by the introduction of practical examples, and in this way incite the students to study intelligently, which is the real measure of his success. We may, however, make the mistake of introducing too many practical details into the course. It is essential above all that the fundamentals of the subject shall be mastered, and the true use of practical problems, aside from securing the interest of the class, is to show that their solution is based on a few broad underlying principles. A practical man may also make a mistake in thinking that his way of looking at a problem is so simple and straightforward that it will surely be grasped by the students. In teaching, however, he will find that after presenting a subject in what he considers a way that all must understand, there will be many, possibly the majority of the class, that have failed to grasp his reasoning. Men's minds work differently, and the path taken to arrive at the understanding of a problem will vary, so that unless a subject is presented in several ways the explanation given by a professor may fail to fall into the line of thought of many of his students, and he will be disappointed in the results obtained.

It is a fact, however, that there are many professors who have had little or no outside experience. This often occurs where a young man enters the profession of teaching directly after his graduation, and is placed in such a position that it is impossible for him to undertake any practical work. Such a professor may make the best sort of a tutor, and may be most successful in imparting the fundamentals of a subject, but when it comes to being put in charge of a practical engineering department, it is here that his lack of experience will be very much felt. In a certain sense it is unfair for a head professor to secure the services of a recent graduate and keep him continually at teaching so as not to allow him to gain outside experience. Much thought has been put on this phase of the problem. Mr.

Walter C. Kerr, in connection with his work as a trustee of Cornell University, has been in favor of the plan that a professor be thrown upon his own resources and be compelled to work in the practical field one year out of seven.* This might appear all right from a business standpoint of the college involved, but how about older professors who have worked long in the teaching line, and have not had the necessary outside experience to qualify them for taking a position in the practical field? It might be very inconvenient for such a professor to have to accept a nominal salary in order to gain experience, but this certainly would follow if he had been so loaded down with teaching that he was given no opportunity to work at the practical side of his profession. On the other hand, if a professor through hard work and diligence has obtained experience in the outside field, while he is a teacher, and is forced, at the end of seven years, to enter the practical field, it is very probable that his success therein may be such that he could not be tempted back to teaching.

From the foundation of the Stevens Institute to the present time, the professors have been encouraged to do practical work. At all times this work has been done on their own responsibility, that is, the institute was not responsible for any of the reports given out. On the other hand, it has been well appreciated that should erroneous or undignified reports be made, it would reflect discredit on the institute, and great care has been taken that this should not occur. In 1894, the late Dr. Morton, who as you all know was the first president of the institute, established what he called the department of tests, the aims of which he described as follows:

"It is part of the institute's policy to make its laboratories and workshops the center of such experimental investigations as will be of direct commercial importance to the mechanical

*After delivering this address the author was informed that this is not Mr. Kerr's plan. What Mr. Kerr has proposed is to appoint two men to each chair, and to have these alternate between the university and the practical engineering world. This would certainly be an ideal plan if the two men thoroughly harmonized in their work, and if the university could meet the additional expense involved.

engineering profession, and likewise contribute to the same valuable technical information by which the knowledge of facts and principles which constitute the foundation of that profession may be enlarged. It is also part of the same policy to have its professors so in touch with the most advanced practice as to enable them to embody, in their courses of instruction, the best results of applied science in engineering practice.

"A department of tests has, therefore, been organized to undertake measurements of the performance of steam-engines and other motors, and of the efficiency of boilers, refrigerating machines and mechanisms generally, including electrical and hydraulic apparatus, also to make tests of strength of materials, and to make various chemical and physical investigations, for the general public. Such work is assigned by the president to the member of the faculty best fitted to successfully undertake any particular investigation, and the extensive facilities of the institute in the way of working space, apparatus, workshop appliances, skilled observers and mechanics are placed at the latter's disposal."

This might make it appear that all testing work from that time on was to be done by the institute as an institution, but such was not the case. No other than personal reports have been issued by the professors who have undertaken the work, and in every case the professors themselves have been entirely responsible for the payment of all expenses connected with the tests. In many cases the expenses of tests are quite large, and the payment of these must be secured either by obtaining a retainer or deposit from the parties for whom the work is to be done, or the professor making the test must run the risk of having to pay these expenses himself should the parties for whom he is doing the work fail to meet their obligations. This looking after the financial end of the problem is an essential one, as it gives the professors experience on the commercial as well as the engineering side of the work.

It has been claimed that the professors of an engineering college should not do work in the practical field, as this interferes with the consulting engineers who depend for their livelihood on just the sort of work that would be apt to be under-

taken at a college. This is a very narrow view to take of the matter, and as far as my own personal experience is concerned, I can testify to the fact that much of the work undertaken in connection with my college duties has been done for consulting experts. The day is past when there can be a strict line drawn between the work of the consulting engineer and that of the professor who teaches in the same field. The ideal professor in a given line should be able to take up the work of the consulting engineer in that line, and the ideal consulting engineer should possess enough technical knowledge to fit him for being a professor. There should be no jealousy, but rather a bond of friendship in that the fundamentals which each should master are the same.

REPORT OF THE SECRETARY OF SECTION D.

The meeting of the section for organization was held in the Engineering building of Tulane University. The vice-president of the section, Fred W. McNair, served as chairman.

Owing to the small number of members in attendance, it was decided to combine the programs of Sections D and B in two joint sessions. These proved to be of general interest and value. The report of the papers offered in Section B will be found on pages 287-294. The following papers were read:

An Experiment on Easterly Deviation Beneath the Earth's Surface: FRED W. MCNAIR, Mich. College of Mines, Houghton, Mich.

The experiment of dropping a steel ball from the top of a shaft forty-two hundred feet deep and finding it lodged in the timbers at a depth of only eight hundred feet from the surface, adds but another example to the general experience that bodies which are dropped in a mine-shaft seldom reach the bottom.

A New Type of Frequency Meter: A. S. LANGSDORF, Washington Univ., St. Louis, Mo.

The device was originally described by the author. (*Proc. A. A. A. S.*, Vol. LIII, 1904, p. 380.) It was independently conceived by Mr. J. F. Begole of the Wagner Electric Manufacturing Company of St. Louis, and has recently been placed on the market. The principle involved in this instrument is based upon the fact that if an alternating (sinusoidal) electromotive force of E volts and frequency $\omega (= 2\pi n)$ is impressed upon a condenser of capacity C farads the current will be

$$I = E\ \omega\ C \text{ amperes.}$$

In other words, for a given value of C, the indications of an ammeter will be proportional to the frequency, *provided* E remains constant, in which case the scale of the ammeter could be graduated to read directly in cycles.

It is of course evident that the assumption of constant electromotive force is not justifiable where commercial circuits are concerned. If the scale of the ammeter mentioned above were graduated to read cycles, a change in line voltage would be recorded as an apparent change in frequency. This difficulty can be overcome, however, if the scale of the ammeter is itself movable and pivoted on a line coaxial with that of the pointer or indicator of the ammeter; if the motion of the scale, due to a

change of voltage, is made equal to, and in the same direction as, that of the ammeter needle, there will be no relative motion between the two, and the reading will remain unaltered.

To secure this compensating scale motion, the scale need only be attached to a wound bobbin which is constructed in all respects like that of an ordinary voltmeter, this voltmeter winding being then connected across the line.

In the instrument as built, the bobbin to which the pointer is fastened, and which carries the condenser current, is mounted either directly above or below the bobbin which carries a graduated scale. Advantage is taken of the fact, suggested by Mr. Begole, that the instrument is a combined voltmeter and frequency-meter. Published in *"Electrical World."*

A Critical Analysis of the Methods of Supplying Power to Branch Telephone Exchanges on the Common Battery System: CARL KINGSLEY, Univ. of Chicago, Chicago, Ill.

The five possible methods are considered, and three of these are chosen as most worthy of critical analysis. In each of the three cases the total costs are determined in terms of the distance from the central, and the total energy to be supplied at the branch exchanges. Three equations are obtained, each of which contains the three variables, cost, distance and energy. For any particular exchange, the method of supply can be therefore readily chosen, which will give the minimum cost of operation. Complete curves have been drawn and a graphical solution of the problem can be obtained by inspection.

The Difference in the Coefficient of Discharge of Steam Through a Single Circular Orifice in a Plate and Through a Number of Circular Orifices in the Same Plate: D. S. JACOBUS, Stevens Institute, Hoboken, N. J.

"The flow of steam through an orifice in a plate was determined and compared with that obtained when six orifices of the same size were placed near each other in the same plate. The flow per orifice was about 14 per cent. greater than with a single orifice. This shows how important it is to consider the conditions which exist on the exhaust side of the orifice The experiments also showed that the position at which the pressure on the exhaust side of the orifice was measured was an important factor, as this pressure varied considerably when measured at different distances from the orifice plate.

The orifices were $\frac{3}{8}''$ in diameter. The pipe conveying steam to the orifice plate and conducting it away from the same was 2" standard size. The orifice plate was placed in a flange union. The single orifice was at the center of the plate, and the six orifices were arranged with one orifice at the center and five midway between the periphery of the center orifice and the inside of the pipe. The pressure on the high pressure side of the orifice was about 147 pounds per square inch, and on the discharge, or low pressure side, about 105 pounds per square inch. The pressure on

the discharge side was measured at a considerable distance from the plate in order to avoid a jet action which existed at a point near the plate, which caused the pressure near the plate to be less than at some little distance from the plate."

Priming Caused by Poor Circulation in a Boiler: D. S. JACOBUS, Stevens Institute, Hoboken, N. J.

A small vertical tubular boiler of about fifteen rated horse-power was employed in the experiments. This boiler was of the ordinary construction with a water heating surface enclosing a circular grate and with tubes leading directly upward from the combustion space above the fire to the upper tube sheet at the top of the boiler. The steam was taken from the boiler at a point in the outer shell near the top of the boiler. When the boiler was run under normal conditions the steam generated was dry for ordinary rates of combustion, and superheated when the boiler was forced to a high capacity.

In this class of a boiler, the temperature of the flue gases escaping from the tubes near the center of the tube sheet is much higher than that of the gases from the outer tubes, and tests were projected to determine whether there should be a gain in the economy through placing retarders in the center tubes, so as to more evenly distribute the work done by the different tubes. In these tests the retarders were so adjusted that the temperature of the escaping gases was made about the same for each of the tubes. After this was done there was an unexpected action through the boiler priming so severely that it was impossible to run it at other than a low capacity. The water level would be constant for a short time and the steam would be dry, when suddenly foam would appear in the gage glass and water would be thrown from the boiler along with the steam. On removing the retarders the priming disappeared, and on replacing them it was again present. It therefore appeared that the retarders caused the priming, and it remains to explain how this could be so.

It seems evident that the priming was caused through a lack of proper circulation in the boiler. Without the retarders the tubes near the center of the boiler were hotter than those near the side and caused an upward current of water at the center of the boiler, and a downward current at the sides, and the circulation was a brisk and definite one. With the retarders, however, all the tubes were at the same temperature and there was no tendency to produce a definite circulation so that the water was quiescent for a time, and after storing a certain amount of heat, it would foam up and some of it would be thrown from the boiler.

The Dual Degree for Engineering Courses: PAUL C. NUGENT, Syracuse University, Syracuse, N. Y.

In the College of Liberal Arts of Syracuse University, the best students are graduated with "Honors" of one of three grades. It has been suggested to adopt the practice in the College of Applied Science. Its object

is to award merit and to stimulate the student to more strenuous efforts to gain a high standing in his class, and to thus result in graduating a better class of men. The first purpose is in a measure fulfilled. It is doubtful whether the second is accomplished at all.

He reviews the two systems for granting degrees now in use in engineering colleges, namely, granting the engineering degree at the end of a four year's course, and secondly, granting the degree of bachelor of science at the end of the undergraduate course, and the full engineering degree on the completion of a year or more of post-graduate work, or two or three years of practical work and on presentation of a thesis. He is strongly in favor of granting the full engineering degree at the end of the four years, and claims that engineering can be taught just as practically and just as professionally as is medicine, and that the engineering graduate is as much entitled to the professional degree as the medical graduate is to the medical degree and the title of "doctor."

The author then suggests a fourth plan. "At the end of the regular four-year course, let two degrees be granted, the B. S. being given to those who have passed in all required subjects, but have failed to attain a certain set grade for all the work of the last three years. This plan places the engineering degree on a higher plane than that occupied by the baccalaureate. It is thought that many students who would not care whether they graduated with 'honors' or not would redouble their efforts when it came to graduating as an 'engineer.' Another result would be that almost every engineering graduate would be a man to whom his college could point with confidence and pride. The B. S. men might be permitted to return for a year to obtain the full degree. The dominant thought of all such work should be quality, and not so much the teaching of new things as the better teaching and more thorough teaching of the old; it should aim to produce better reasoning powers and general ability in the student, and failing that, the full degree should never be granted." The paper received considerable discussion and elicited much opposition. Engineering professors, as a rule, seem to be quite well satisfied with the present practice of their respective institutions.

Panama: A Discussion of the Present Conditions and the Prospects: FULLERTON L. WALDO, New York, N. Y.

The paper is true to its title, discusses the various reports of the present conditions, gives examples of these conditions, show why they are so, and then bears worthy tribute to the character, integrity and engineering ability of the Canal Commissioner, the late George S. Morison:

"Mr. Morison insisted that we must take two years to clean up the mess left by the French, to burn the hovels, to drain the swamps, to petrolize the breeding places of the mosquito, and to build clean, wholesome houses for the men. He went down there himself and put his fingers into the dry-rot, and found there the seeds of his own mortal illness. Whitewash,

either in engineering or in politics, could not fool him. Had he lived, he might have been able to check the tendency to 'hustle' in the scrambling ambition to make dirt fly, simply that the foolable part of our country's population might be deceived by the specious appearance of 'something doing.' All calamity howlers to the contrary, notwithstanding, the canal is as sure to be built as that a natural law is certain of fulfillment; and those who to-day busy themselves trying to find arguments against it are going to be ashamed and sorry when the seas are eventually linked by the greatest engineering undertaking in the history of mankind."

Mr. Waldo speaks knowingly and "makes clear the fundamental soundness of the Panama Canal proposition, and the nature of the temporary difficulties which have hampered the execution of the plans."

Mr. Worcester R. Warner of Cleveland, Ohio, who spent a week on the Isthmus in the winter of 1904-5 with the Congressional Committee, presented a paper on his—

Observations on the Panama Canal: WORCESTER R. WARNER, Cleveland, Ohio.

"The cause of the failure of the French Company was primarily, and almost wholly, due to maladministration, which is indicated by the ruins of expensive machinery now lying along the route of the canal, more particularly near the Atlantic terminus. Twenty-five years ago, the control of the Chagres River was considered the difficult problem; now it is considered only ten or fifteen per cent. of the problem. Now the great difficulty is the excavation of the material from the Culebra Cut. The great wonder of the canal is that so much of it is practically level. From Colon to Gamboa, the fall is only two feet per mile for twenty-eight miles. Ten miles at the Pacific end of the canal compares in grade with the Atlantic end. This leaves about ten miles through the Culebra Cut, which can be considered as embodying practically all the difficulties in excavation.

"If a sea-level canal is constructed, a dam will be required at Gamboa, where there is a splendid foundation for it, and it would make an artificial lake with sufficient capacity to care for the largest freshets whose waters would be drawn off towards the oceans by routes other than the canal bed. Sufficient water would be let into the canal to provide the necessary power for generating electricity for lighting and power purposes. On the other hand, if a lock canal is constructed, a dam 2,000 feet long must be built at Bohio, and possibly another at Gatun, on foundations which are found only at 150 feet or more below sea level, and they can be constructed only with the greatest trouble and at an enormous expense. That a dirt dam at Bohio has been suggested seems hardly credible.

"When we consider that the maximum height of the canal at the beginning was less than the height of some of our modern buildings, and

that the French Company reduced that height to 150 feet above sea-level, which is practically the height of our nine or ten story buildings, and further, that this height extends only for less than ten miles, Mr. Warner is confident that if the present Congress does not direct a sea-level, to be built, that the next one will, for our government engineering works in the past have not been conducted on the 'penny-wise and pound-foolish' plan.

"One other argument should be mentioned, and that is that without exception the great engineering works of the present generation have proven themselves too small and too limited. This is illustrated by the 'Soo' canal, the first locks of which were discarded years ago and larger ones built, which are soon to be replaced by others still larger. If the Panama Canal is built on the sea-level plan, it can be enlarged without interfering with traffic and without difficulty. On the other hand, if a lock system is used it is limited, and cannot be enlarged without being rebuilt."

The vice-presidential address was delivered by Professor Jacobus in the assembly room of Gibson Hall. The subject which he chose was "Commercial Investigations and Tests in Connection with College Work." It was concurred in and heartily appreciated by the members of the section and association who had the pleasure of listening to it. It was published in full in the issue of SCIENCE for January 19th, 1906, and will be found on page 92. It was also published in the January issue of the STEVENS INSTITUTE INDICATOR, (Vol. XXIII, page 7). The author quoted Mr. Walter C. Kerr, in connection with his work as trustee of Cornell University, as being in favor of the plan that a professor shall be thrown upon his own resources and be compelled to work in the practical field one year out of seven. It seems that the author was misinformed as to Mr. Kerr's real meaning, and that Mr. Kerr has called his attention to the matter in a letter which will be found in the April issue of the STEVENS INSTITUTE INDICATOR. Mr. Kerr explains his ideas at some length, and includes a memorandum on the subject which he made to President Schurman. Eight other letters are included commending the substance of this address and pleading for the more intimate connection of engineering professors with actual practice.

WM T. MAGRUDER
Secretary.

SECTION E.

Geology and Geography.

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ADDRESS

BY

EUGENE A. SMITH,

VICE-PRESIDENT AND CHAIRMAN OF SECTION E FOR 1905.

ON SOME POST-EOCENE AND OTHER FORMATIONS OF THE GULF REGION OF THE UNITED STATES.

In 1871, Dr. Eugene W. Hilgard, formerly state geologist of Mississippi, read before the American Association for the Advancement of Science a paper "On the Geology of the Gulf of Mexico." This paper was supplemented in 1881 by another, "On the Later Tertiaries of the Gulf of Mexico," in which account was taken of the geological investigations made in the interval.

In both these papers that problematical formation, the Grand Gulf, held the chief place of interest, and the hypothesis of a temporary and partial isolation of the gulf from the Atlantic Ocean was urged as being necessary to account for its phenomena.

On the present occasion, I purpose to speak of some additions to our knowledge of the geology of the gulf coastal plain, since 1881, and especially of the post-Eocene formations; and if in this summary I shall be thought to dwell too much on Alabama, I shall urge in explanation that the opportunities for the study of these formations in Alabama are, perhaps, better and more favorable than in the other states, and I might add that my personal acquaintance with these formations in Alabama is much larger than in the other states concerned.

CRETACEOUS.

In the Cretaceous, the principal advance seems to have been the discovery or discrimination of a lower division, represented in Texas, the Indian Territory and Arkansas by the Comanche series, and in the Gulf states east of the Mississippi, by the Tuscaloosa formation.

"The Comanche includes in ascending order three groups, the Trinity, the Fredericksburg and the Washita. By means of its flora the Tuscaloosa formation has been correlated with the Raritan formation of New Jersey, which is placed at the top of the Lower Cretaceous (Potomac group) of that region. A somewhat similar unstudied flora occurs in the Cheyenne sandstone of southern Kansas, which is certainly in the upper portion of the Comanche series and probably within the Washita group. The Tuscaloosa, therefore, seems to be about on the horizon of the Washita group and may represent it in whole or in part."*

The Tuscaloosa strata were well and fully described by Hilgard in his "Geology of Mississippi," but both by himself and by Tuomey, of Alabama, were included in their Eutaw formation, as its lowest member; but subsequent study in Alabama, especially of the plant remains of the formation, led to the separation of these beds from the other Eutaw strata and the establishment of their equivalencies as above indicated.

It has also been recently shown that very much of the Rotten Limestone division of the Cretaceous is largely composed of foraminiferal shells and is, therefore, of the nature of chalk, and in Alabama the name Selma chalk has been given to it.

It may further be noted as a matter of interest that the suitability of the purer beds of this chalk as material for the manufacture of Portland cement has been amply demonstrated by the success of the Demopolis (Alabama) cement plant.

*T. W. Stanton, letter of November 1, 1905.

TERTIARY AND LATER FORMATIONS.

These I prefer to consider together, for the reason that the precise line between the Tertiary and post-Tertiary can hardly be said to be definitely fixed as yet.

Since 1881 much geological work has been done in the Tertiary formations of Alabama, especially in the beds below the Lower Claiborne or Buhrstone (the Northern Lignitic of Hilgard), and their stratigraphic relations along the Tombigbee, Alabama and Chattahoochee rivers have been carefully worked out, and described in Bulletin 43 of the United States Geological Survey, and more fully in the Report on the Coastal Plain of Alabama, published in 1894, by the Geological Survey of Alabama.

While in Mississippi in these lower beds the lignitic character is more pronounced, in Alabama the marine facies is better developed, and the existence of a number of beds with well-preserved marine shells has made possible a greater degree of differentiation than could be obtained in the adjoining states; though several of these marine deposits of the Alabama Lignitic have been traced into Mississippi on the one hand, and into Georgia on the other.

In 1880, while acting as special agent of the tenth census, the present speaker showed that the Vicksburg limestone was the underlying formation of the Florida peninsula down nearly to the Everglades, and that this limestone at a number of points was overlain by another limestone or marl containing Miocene shells.*

The Miocene localities then observed were, however, mostly on the Atlantic side of the peninsula, to which region our investigations were mainly confined.

Little or nothing was done in continuation of these observations until 1887, when Daniel W. Langdon, of the Alabama Geological Survey, discovered on the Chattahoochee river a series of marine Tertiary beds of Miocene age directly overlying the Vicksburg limestone, which, before that time, had been con-

*Vol. VI., Quarto Reports, Tenth Census.

sidered the uppermost of the marine Tertiary formations of the Gulf coast.* By this capital discovery, interest in the later Tertiary formations of this region, especially in Florida, was greatly stimulated, in part because of the great number and beautiful state of preservation of the fossil shells, and the geologists, paleontologists and shell collectors of the U. S. Geological Survey were soon abroad in the land, with the result that other occurrences of Miocene strata were speedily made known, especially east of the Chattahoochee river, at Coe's Mill and other localities down the western side of the peninsula where the exposures are more numerous and continuous.

West of the Chattahoochee also, on Chipola river not far from Alum Bluff, on Shoal river in Walton county, and even as far westward as Oak Grove on Yellow river in Santa Rosa county, a few miles below the Alabama line, beds with Miocene shells in an almost perfect state of preservation were quickly added to the list of desirable collecting grounds.

North of Oak Grove and on the banks of the Conecuh river near Roberts in Escambia county, Alabama, some poorly preserved but still identifiable shell casts of Miocene forms were found by Mr. L. C. Johnson, of the Alabama Geological Survey, in beds which were very close above the Vicksburg limestone and consequently near the horizon of the lower Chattahoochee. The westernmost occurrence of the post Eocene marine Tertiaries was also discovered by Mr. Johnson near Merrill in Greene county, Mississippi, at the confluence of Leaf and Chickasawhay rivers, which make the Pascagoula. Here in the banks of Chickasawhay is a bed made up almost exclusively of the shells of a small *gnathodon* or *rangia*, along with some large but very badly preserved oysters (*O. Virginica*).

Inasmuch as this was in territory mapped by Hilgard as Grand Gulf, and as the strata of the latter formation, containing lignitized and silicified trunks of trees, formed the upper two-thirds of the bluff at the place, the gnathodon bed was considered as a *part* of the Grand Gulf, and the name Pascagoula was given to it. Provisionally, at least, the horizon was de-

*Report on the Coastal Plain of Alabama, Montgomery, Alabama, 1894.

termined to be Miocene and equivalent to the uppermost of the Alum Bluff beds, but the subsequent determination by Mr. Dall of the oyster above mentioned, as *O. Virginica*, would make the horizon Pliocene, since *O. Virginica* is not known in strata older than the Pliocene.

It may be here remarked that this shell-bearing bed is not a part of the Grand Gulf, since in a deep well bored in Mobile, Ala., in 1894-5, it was penetrated at the depth of 700 feet, while the Grand Gulf there is at the surface.

But the Chattahoochee river section still held the first place, as alone showing clearly and unmistakably the order and succession of most of these beds; for, from Chattahoochee Landing down to Alum Bluff, as first demonstrated by Langdon and since verified by numerous geologists, there is a practically unbroken series of marine strata exposed along the banks and bluffs of the river.

At several points, and especially in the upper part of the Chattahoochee series, there are beds with well-preserved shells which have been studied and described mainly by Professor Dall, who has classed them as Oligocene and Miocene.

Their thickness, as estimated by Messrs. Pumpelly and Dall, is 200 feet, but the well borings in Mobile have since shown that a greater thickness must probably be allowed.

It will be remembered by those who have kept pace with the progress of gulf coast geology that up to 1881, when the last paper of Hilgard's above referred to was written, the Grand Gulf, a non-marine formation, had always been observed to be, along its northern border, in contact with the Vicksburg limestone, and to occupy the surface of the coastal plain (of Mississippi, at least), thence southward to within ten miles of the gulf shores.

No other Tertiary formation younger than the Vicksburg had then been observed *underlying* it, or indeed outcropping at all in this coastal plain, and none *overlying* it older than the Stratified Drift or Orange Sand (since called Lafayette), and its position in the geological column seemed thus to be definitely fixed, leading Hilgard to the conclusion that "its rocks alone represented on the northern border of the gulf, the entire time

and space intervening between the Vicksburg epoch of the Eocene and the Stratified Drift."

This view was generally accepted by the geologists of the gulf coastal plain, since similar relations between Vicksburg and the Grand Gulf beds had been observed and described at various points from Texas to the Perdido river.

At this time (1881), the Grand Gulf beds had been identified in Alabama through Washington and Baldwin counties to the Perdido river, the boundary between Alabama and western Florida; and in Georgia the siliceous strata of the wire-grass region, since designated Altamaha grit, were correlated by Drs. Loughridge and Hilgard with the Grand Gulf of Mississippi and Alabama;* but neither in Alabama, nor in Florida, nor in Georgia, had the superficial distribution of these beds been at all fully mapped; only detached occurrences had been noticed. West of the Mississippi river, also, the Grand Gulf had been identified and partially mapped through Louisiana and Texas.

The discovery by Langdon of the marine Miocene beds of the Chattahoochee occupying a part at least of the position hitherto thought to be monopolized by the Grand Gulf, naturally necessitated some modification of Hilgard's view, and this necessity was emphasized by the subsequent discoveries mentioned, of beds with marine and estuarine shells of Miocene and Pliocene age at other localities in Mississippi, Alabama and Florida, in territory known to be occupied, superficially at least, by unquestioned and unmistakable Grand Gulf strata.

At first, as we have seen, the supposition was put forward that the Pascagoula bed was an estuarine deposit *in* the Grand Gulf and a part of that formation, then, considering the conditions at Roberts in Escambia county, Ala., where typical Grand Gulf sandstones and clays (from the relative positions of their surface outcrops) *appeared* to lie between the Vicksburg limestone and the beds with the Miocene shells, the Miocene age of the Grand Gulf, and the fact of the gradual replacement, coming eastward, of its non-marine beds by marine equivalents, were thought to have been established; and

*Tenth Census Report, Vol. V.

finally, in the Chattahoochee river section, it was thought that we had proof of the complete replacement of non-marine by marine strata.

At that time the presence of Grand Gulf beds of the characteristic *non-marine* type, overlying, and neither interstratified with nor replacing, the *marine* Miocene beds of the Chattahoochee series, had not been demonstrated as has since been done by many observations, and in reaching the above-mentioned erroneous conclusions regarding the Miocene age and equivalents of the Grand Gulf, we were dominated by the idea suggested by its relations to the Vicksburg limestone, which it almost everywhere immediately overlies, that it must, therefore, be the immediate successor of this limestone in the geological sequence.

It seems almost impossible to eradicate this belief, notwithstanding its absolute disproof by the records of the Mobile well alone.

Other equally incontestable, though perhaps not quite so obvious, proofs of the true position of the Grand Gulf in the geological column have been obtained by the field investigations in Mississippi, Alabama, Florida and Georgia during the years 1900–1904. As long ago as 1860, Dr. Hilgard, that most sagacious of southern geologists, described and mapped correctly the Grand Gulf as covering all the lower part of Mississippi from the Vicksburg outcrop down to within ten miles of the gulf, and with no formation overlying it older than the Stratified Drift or Lafayette. In Alabama, west Florida and Georgia a similar condition of things exists, as will be evident from the following instances:

1. From Healing Springs in Washington county, Ala., down through Mobile county to within a few miles of the gulf, the surface formation is everywhere the Grand Gulf with its usual capping of Lafayette.

2. A little further east in Alabama, beginning in Clarke county and coming southward through Baldwin to Perdido bay, we find again nothing at the surface save Grand Gulf with its Lafayette capping. At Montrose, on the eastern shore of Mobile bay and a little below the latitude of Mobile, these

Grand Gulf clays and sands of the most characteristic type make the Red Bluff, seventy-five feet in height, with the usual thin capping (fifteen or twenty feet) of Lafayette red loam and pebbles. Continuing on down to the southern end of the county we find the same materials making a bluff twenty-five or thirty feet in height, washed by the waters of Perdido bay, *i. e.*, the Gulf of Mexico. So here in Alabama, the Grand Gulf most certainly overlies *everything* except the Lafayette and more recent strata.

3. Again along the L. & N. R. R. we have followed the same combination, Grand Gulf with Lafayette capping, from above Evergreen down to Pensacola, where they form a bluff some thirty to forty feet in height overlooking the Bay of Pensacola.

4. Again in Escambia county, Ala., starting north of the Conecuh river near Roberts, we find the Grand Gulf overlying and in contact, first with the Vicksburg limestone, then with the Miocene clayey sands which there directly overlie the Vicksburg; then, coming southward into Florida, the same formation with its capping of Lafayette occupies the surface down to the latitude of Oak Grove and beyond, the Oak Grove bed with its beautiful Miocene fossils cropping out in the bank of the river, the Grand Gulf on the uplands one hundred feet above.

5. Eastward of Escambia county the northern limit of the Grand Gulf laps over formations still older than the Vicksburg, and we see it in Covington county near Andalusia, overlying the Claiborne and the Buhrstone; and in Barbour county and the adjoining (Quitman) county in Georgia, opposite Eufaula, it overlies the Ripley beds of the Cretaceous. Thence, its landward border takes a northeasterly direction, and indurated beds identical with those of the type locality in Mississippi (here called Altamaha Grit) begin to make a small percentage (not more than one one-hundredth of one per cent. according to Dr. Harper) of the rocks of the series, eastward of Flint river.

From this northern border it may be traced southward to the southern limit of the state, and beyond, at least to Chattahoochee in Florida, where it occupies as usual, the summit of the plateau with only the red loam and pebbles of the Lafayette

over it; and along the road leading down from this plateau to the Old Chattahoochee Landing it may be seen resting directly upon the Miocene limestone first identified as such by Langdon as above mentioned.

While our recent observations have not extended any further south along the Chattahoochee than this point, we have good reason for the belief that the same Grand Gulf and Lafayette mantle occupies the summit of Alum Bluff itself.

Keeping in mind the fact that the Grand Gulf mottled clays overlie directly the Miocene limestone at Chattahoochee Landing, let us consider what the deep borings at Mobile, at Alabama Port, Mobile county, and at Bon Secours bay in Baldwin county, reveal. In all these wells, with the Grand Gulf capped with the Lafayette forming the surface, the Gnathodon bed of the Pascagoula Pliocene is penetrated at the depth of 700 to 800 feet; and below that, to the depth of 1,600 feet, follows a succession of beds with well preserved and easily identifiable shells, characteristic of the several horizons of the Chattahoochee (Miocene) river section. The borings end in these beds before reaching the top of the Vicksburg.

The most remarkable thing in connection with these later Tertiary strata and that which has caused so much perplexity among the geologists, is the rarity of their outcrops at the surface west of the Chattahoochee river. There are several known exposures in west Florida already noticed, *i. e.*, on Chipola river, Shoal river and at Oak Grove; only one locality has as yet been noticed in Alabama, *i. e.*, on Conecuh river near Roberts in Escambia county; only one in Mississippi, viz., that of the gnathodon bed near Merrill on Chickasawhay river. We hear of none in Louisiana, and none in Texas; yet in the latter state the deep borings at Galveston and Beaumont, after passing through 458 feet of recent and Pleistocene strata, and 1,035 feet of beds of doubtful age, penetrate at least 650 feet of beds referred to the Upper Tertiary, and 917 feet of beds containing characteristic shells of Miocene age.* We know the reason of this in Alabama, for the surface of the country here in which they should outcrop is covered by an un-

*Gilbert D. Harris, Fourth Annual Report, Geological Survey of Texas, 1892, pp. 91–95.

determined thickness of the beds of the Grand Gulf and Lafayette. Probably the same explanation would apply to the other states.

From the facts detailed above, the conclusion seems unavoidable that the Grand Gulf lies *above* any Tertiary formation as yet described in the Gulf states, it being, on the testimony of the Mobile wells, at least 700 feet above the Pascagoula beds, which, from the *O. Virginica* which they contain, must be assigned to the Pliocene. The additional fact that no formation older than the Lafayette has yet been observed overlying it, betokens its comparatively recent age.

The only escape from the conclusion thus forced upon us seems to be the assumption that Wailes, Hilgard, Hopkins, Loughridge, Hill, Kennedy, Dumble and the other geologists who have made this region a study, have been mistaken in their identifications of the Grand Gulf, and have confounded it with something else.

Let us, therefore, look at it from another point of view. The usual place assigned to the Grand Gulf is between the Vicksburg and the Chattahoochee limestones, or between the members of the Chattahoochee river series, or else as being equivalent to the whole of the above series.

We ought, if this assignment be correct, to find it somewhere or other *underlying* some of the Post-Vicksburg Tertiary rocks. It has never yet, so far as the records show, been seen in these relations.

That it does not come in betwen the Vicksburg and Chattahoochee is amply proven by the observations of Professors Pumpelly, Foerste, McCallie, Burns, Dall and others who have described the contact of these formations in southwestern Georgia and in Florida, with no sign of anything that could possibly be referred to the Grand Gulf coming in between them.

Characteristic Grand Gulf beds were observed by Mr. S. W. McCallie and myself in 1904, on Withlacoochee river in Lowndes county, Ga., near the Florida line, overlying limestones holding Miocene corals referred to the Chattahoochee horizon, this limestone in its turn resting on the Vicksburg; and I can personally bear witness to the fact that the Grand Gulf

overlies the Miocene limestones at old Chattahoochee Landing, and along the road from Chattahoochee town to River Junction. From Chattahoochee Landing down to Alum Bluff, the succession of Marine Tertiary beds along the river is unbroken; in the words of Professor Dall, "While the series is not complete in any single section, taken collectively there is no gap outstanding between the beds, and, humanly speaking, no room for misapprehension as to their position and age."* Certainly no Grand Gulf beds form any part of this Chattahoochee river section, which ranges from upper Oligocene, according to the latest decision of Professor Dall, up to the Chesapeake Miocene of the Alum Bluff exposure; but they do *overlie* in turn each member of this series.

But we have also seen above, that eastward of Escambia county, Ala., the Grand Gulf beds are to be found overlying strata *older* than the Vicksburg, *e. g.*, the Claiborne, the Buhrstone, the Lignitic, the Clayton, and even the Ripley of the Cretaceous. It has not occurred to any one to assign to the Grand Gulf an age older than that first referred to, because of its resting directly upon any of these sub-Vicksburg formations.

By way of parenthesis, I might here say that this transgression of the Grand Gulf over the older formations in the eastern part of Alabama, finds a kind of parallel on the St. Stephens limestone. We have recently identified isolated patches of this limestone so far out of its usual position as to be directly in contact with the Nanafalia beds of the Lignitic and upon the very verge of the Clayton. This is the case, for instance, at Rutledge and Luverne in Crenshaw county and at Brundidge in Pike county, Ala. Between these outlying patches and the regular outcrop of the St. Stephens is the usual succession of the outcrops of the other Lignitic and Claiborne beds, with none of the Vicksburg remnants, as yet detected, overlying them.

We may sum up the evidence above presented in the two following statements: (1) No one has yet seen or recorded the Grand Gulf actually in place *beneath* any Tertiary formation, Eocene, Oligocene, Miocene or Pliocene. (2) On the other

Bulletin Geol. Soc. Amer., Vol. 5, p. 162.

hand, it has been observed *overlying*, and in direct contact with, every one of these Tertiaries, to say nothing of the Ripley of the Cretaceous.

It has been inferred that it passes below all the Tertiaries above the Vicksburg, simply because of the usual position of its northern boundary, ignoring what Hilgard long ago emphasized that, apart from local steep dips in any direction, its strata could nowhere be shown to have anything else than approximately horizontal position, on an average; and ignoring the still more convincing circumstance that, with a thickness of only 200 to 300 feet, it spreads over an area in the state of Mississippi of at least 120 miles from north to south. If it had the usual observed dips of the other Tertiary formations in that state, the Grand Gulf would lie between 3,000 and 4,000 feet *below* the surface at points near the Gulf where it is certainly known to be *at* the surface.

MATERIALS.

"The materials of the Grand Gulf are essentially clays and sandstones, the latter generally aluminous and soft, and of white, gray and yellowish-gray tints, the sand being very sharp. Beds of loose sand are unusual; but the clays are oftentimes quite meager, though the sand contained in them (as is the case in the sandstones) is usually quite fine."

To this description by Hilgard it might be added that the sandstones and the massive clays, which are often indurated into a mudstone grading into a sandstone, are frequently mottled with irregular red splotches, in this particular, as well as in others, resembling some of the material of the Tuscaloosa formation of the Cretaceous.

Stratified clays in thin layers are also common in Alabama, and these very often have a pink color. Pebbles of small size, one-fourth to one-half inch in diameter, are not uncommon in thin irregular bodies, generally at the base of sandy beds. Much stress has been laid on the occurrence of the sandstones and other indurated strata as being only in the presumably lowermost (because most northerly) beds of the formation;

but this is a mistake, since one of the most conspicuous examples of this occurrence is at Fort Adams on the Mississippi river, in the southwestern corner of Mississippi, at the Louisiana line. In Alabama they occur down to the Florida line, and in the Altamaha Grit region of Georgia—as shown by McCallie, Harper, Burns and others—these indurated beds, in every respect identical with those of the type locality in Mississippi, have been observed sporadically in eighteen counties and in every part of this region, down nearly to the Florida line in southwestern Georgia, and to within twenty-five or thirty miles of the Atlantic coast on Ocmulgee river. According to the estimate above referred to of Dr. Harper, who has devoted several years to the study of this region, these *rock outcrops* do not constitute more than one one-hundredth of one per cent. of the area of the formation.

The marks on the map before you will show this clearly enough, and ought to dispose of the statement so often made that the indurated parts of the Grand Gulf are older than the rest—or that they represent a different formation from the less consolidated parts. One might as reasonably hold that the indurated crusts so often seen in the Lafayette constitute a distinct formation worthy of a distinct name. In general, however, the statement of Hilgard holds good, that "there is a gradual increase in clayeyness and a decrease of hardness, until in the seaward portions of the formation we find chiefly stiff blue or green and more or less massy clays."* and I might add for Alabama, laminated clays and coarse sands.

Lignite and gypsum are characteristic of the materials both in Alabama and in Mississippi, and in both states the wood is often silicified. The lignitic facies is, however, more common in Mississippi. The lignitic matters generally occur in rather limited lenses in the other strata. Some of the trunks of trees have been observed one-half silicified, the other half lignitized.

Am. Journ. Sci., Vol. XXII, p. 59.

TOPOGRAPHY.

The topographical features of the country covered by the Grand Gulf strata are quite characteristic. Near the northern border where the Vicksburg limestone is not far below the surface, lime sinks and deep ponds are common, and the surface of the country is often uneven, occasionally rugged; but going southward one finds the surface becoming gradually smoother until it assumes the character of "flatwoods." But these flatwoods are not necessarily low lands, since in Baldwin and Mobile and in the adjoining county of Florida (Escambia) the land, where not lowered by stream erosion, is from 150 to 300 feet above tide. One of the most characteristic features of this flat land is the frequent occurrence of shallow depressions which are hardly ever more than four or five feet deep, in which water may collect in shallow ponds a few yards to forty or fifty in diameter. These are lined with a shrubby growth of haw bushes, gum or cypress, or sometimes of herbaceous plants only. Other depressions, frequently of larger size than those above mentioned, may be free of water, thus giving rise to the *sarracenia* flats and to *savannahs*, covered with high grass and supporting a sparse growth of stunted long leaf pine. Along with the prevailing grass are many bright-colored flowers peculiar to the region, and the impression is made upon the traveler that he is in a well kept park. Lower lying lands timbered with long leaf and Cuban pine are known as "pine meadows," in which the shallow ponds are not so frequent, but where the surface is gently undulating and mostly clothed with a growth of tall grass and flowers, like the savannahs.

It is not easy to account for these shallow depressions; they are certainly not due to any underlying limestone near the surface, nor is there, so far as we are aware, any sufficient amount of soluble matters in the soils to give rise to them. The only explanation as yet suggested is that they are due to the uneven surface of the underlying clayey beds of the formation, which are reached almost everywhere in wells at shallow depth.

THICKNESS.

The thickness of the formation is very difficult to estimate. Dr. Hilgard long ago observed that "the position of the Grand Gulf strata could rarely be shown to be otherwise than nearly or quite horizontal on an average," and during a recent trip by Mr. Aldrich and myself in a skiff, from Bucatunna to Merrill in Mississippi, a distance of fifty miles in direct line north and south, we could discover no sensible dip in the strata. Dr. Hilgard puts the thickness at 250 feet, stating that in the absence of deep borings in the gulf territory this can be best observed on the northern edge of the formation, where it forms high ridges, from which there is an abrupt descent northward into the level prairie country of the Vicksburg territory. The deep borings since made in the gulf territory have not settled the question, for it is not as yet possible to draw sharply the line between the Grand Gulf and other strata there penetrated. In Baldwin county, where these beds come down to salt water at Montrose on the eastern shore of Mobile bay, the bluff itself is some 70 or 75 feet high, and the level plateau, a mile or two back from the bay, can not be less than 150 feet. This is about the height of the Spring Hill plateau at Mobile, and at the foot of that ridge is the boring in which the Pascagoula bed is struck at about 700 feet. For the first 180 feet of this boring the material can not well be distinguished from Grand Gulf. This, with the 150 feet of the hill, would make the thickness something over 300 feet.

From its structure and distribution it is difficult to avoid the conclusion that the Grand Gulf is a sort of blanket or mantle formation spread over part of the Vicksburg; in places over parts of older formations; and over all the Miocene and later Tertiaries, with practically no general southward dip more rapid than the descent of the general land surface. In this it resembles the next overlying formation of our coastal plain, viz., the Lafayette or Orange Sand of Dr. Hilgard. The latter, however, overlies a far greater number of formations, including the entire coastal plain series and even part of the Paleozoics and Crystalline schists The Lafayette is also composed of

siliceous materials, but my experience in Alabama is that the clays are comparatively rare. The prevailing material is a red sandy loam with beds of rounded, water-worn pebbles in irregular bodies at the base. Very often the red loam passes into a sandier phase of lighter color—generally yellowish—before the pebbles are reached. The thickness can rarely be shown to be more than twenty or twenty-five feet at any one place, unless the materials are filling erosion hollows in the underlying formations. A characteristic feature in Alabama is the almost total absence of evenly stratified beds of any kind; the red loam at the surface seldom shows any lines of stratification; the sands and pebbles almost invariably exhibit cross-stratification or false-bedding, due to deposition from swiftly flowing currents; laminated clays I have not seen at all in this formation in Alabama. In this we have a very marked distinction of the Lafayette from either the Tuscaloosa or the Grand Gulf, with both of which it has some features in common.

GENESIS.

To account for many of the phenomena of the Grand Gulf formation Dr. Hilgard has from the first insisted that foremost among the conditions of its accumulation was exclusion of the sea,* or at least such obstruction of the communication across the still submerged peninsula of Florida as to render the influx from the interior of the continent predominant over the original supply of sea water. Later, in 1881, after soundings in the Gulf of Mexico had revealed the topography of the gulf bottom, and the existence of a submerged shelf of 100 to 130 miles width along the coast, he suggested that even an elevation of 450 feet (which seems to be proven for the Mississippi embayment) would convert the whole gulf border into a region of shallows out to the 100-fathom line, in which the waters would be kept permanently freshened by the continental drainage. It may be remarked in this connection that such an elevation would also raise a portion of the present sea bottom into dry land, and would not help to explain the accumulation of Grand Gulf strata far inland of the present coast, unless we assume

*Am. Journ. Sci., Vol. II., December, 1871.

that this uplifting of the submerged shelf was accompanied by a downward warping of a belt farther inland. Nor would it help in the explanation of the occurrence of this formation on the Atlantic side of the Georgia watershed, and through South Carolina.

In the Tuscaloosa or Potomac formation of the Cretaceous we have an almost parallel case. In their component materials and in their mode of accumulation the two formations show striking similarities; in both are only vegetable remains, or those of land and fresh-water origin; both must have been accumulated in sounds, partially, at least, cut off from the sea, and the difficulties in suggesting the precise nature and origin of the barrier by which this exclusion of the sea was effected, are as great in the one case as in the other, but in neither greater than the difficulties met in accounting for the other great fresh-water formation of the coastal plain—the Lafayette.

In the case of this Lafayette formation, two explanations of its origin have been offered, viz:

(1) That it was deposited along the borders of the Gulf and Atlantic during a period of depression, when the shore line was at the landward margin of the formation, and that the deposit was, therefore, a marine or estuarine one.

To this the structure of the formation, its position upon a deeply eroded surface, and the entire absence of fossil remains appear to be well-nigh insuperable objections.

(2) That the materials were drifted down the channels of ancient streams, in places coincident in position with the modern streams, and were thus of the nature of alluvial fans. All this would naturally happen during a period of elevation rather than of depression. In Alabama, the Lafayette does not seem to be confined to well-marked channels such as Dr. Hilgard finds in Mississippi; but it appears to have been spread over the whole face of the coastal plain of the Gulf as well as of the Atlantic, reminding one of a coalescence of alluvial fans on a large scale, as they spread out upon the plain, much after the fashion of the ice of the Piedmont type of glacier as displayed by the Malaspina. This view of the genesis of the for-

mation would account for many of the phenomena, and certainly for the absolute lack of all trace of fossils.

In the nature of their materials; beds of sand often intricately false-bedded and of bright colors; beautifully laminated and gaily colored clays; great beds of massive clays of every variety, white, gray, reddish, purple and variously mottled; in their structure and in the general impression which they make upon the observer in the field, the two formations, Potomac and Grand Gulf, are astonishingly alike, so that in the absence of fossils it would be impossible to distinguish the one from the other if both occurred in the same area. On the other hand, the Lafayette has a character of its own, different from either, and so well marked that the observer with any reasonable degree of experience will scarcely ever remain long in doubt as to its identity or be likely to confound it with anything else, even though it holds no fossils to guide him.

REPORT OF THE SECRETARY OF SECTION E.

The section was called to order by Professor Eugene A. Smith, retiring vice-president, who introduced and resigned the chair to his successor, Professor Willam North Rice. On motion, L. C. Glenn of Vanderbilt University was elected secretary *pro tem.* in the absence of the regular secretary of the section, E. O Hovey. C. R. Van Hise was elected a member of the council, E. H. Barbour a member of the general committee and L. C. Glenn press secretary. Fifty-nine members of the association were recommended for promotion to fellowship, forty of them on the basis of their membership in societies of high technical standing.

The address of the retiring Vice-president, Eugene A. Smith, was entitled "On some Post-Eocene and Other Formations of the Gulf Region of the United States;" Eleven other papers were upon the program, six of which were read in full by their authors. The other five were read in abstract or in full by the secretary *pro tem.* in the absence of their authors. Abstracts of all the papers read follow:

On the Use of the Words Synclinorium and Anticlinorium: WILLIAM NORTH RICE.

A technical term once introduced should be retained in the original sense. If in the progress of thought the concept which a word expresses ceases to be useful, the word may become obsolete, but should not be used to express a totally different idea.

Secondly, a technical term should be etymologically appropriate.

The words *synclinorium* and *anticlinorium* were introduced by James D. Dana.* According to the form of the contraction theory of mountain-making developed by Dana, most monogenetic mountain ranges were believed to have been made by the crushing of the strata in a geosyncline. Such a range he proposed to call a *synclinorium.* The final part of the word is from ὄρος, mountain, and the word is altogether appropriate etymologically. Dana, however, recognized that a somewhat permanent line of elevation might be formed as a geanticline, a considerable area of the crust being elevated into a gentle arch without any considerable disturbance of the strata. Such a range he proposed to call an *anticlinorium.* As an example of an anticlinorium he cited the "Cincinnati Uplift" formed in mid-Paleozoic time, nearly contemporaneously with the Taconic synclinorium.

The words synclinorium and anticlinorium are accordingly not stratigraphic, but orographic terms. They denote two types of mountain elevations.

American Journal of Science, Series 3, Vol. 5, pp 431, 432.

I believe the anticlinorium type is more important than Dana himself supposed. The Appalachian range, for instance, was formed as a synclinorium in post-Carboniferous time, subsequently peneplained, and re-elevated as an anticlinorium in Tertiary time. This remark is made in passing, as it is not my purpose at present to discuss the theory of mountain making.

It is much to be regretted that several recent writers have used the words in entirely different senses. Van Hise unhappily set the example in his masterly—his really epoch-making—studies of rock deformation.* He uses the words in a purely stratigraphic sense, making an anticlinorium simply a compound anticline, and a synclinorium a compound syncline. He distinguishes synclinorium and anticlinorium from geosyncline and geanticline, using the latter pair of words substantially in the sense in which Dana used them. The etymology of the words synclinorium and anticlinorium is as inappropriate in the new sense as it was appropriate in the original sense.

Sir Archibald Geikie† and Scott ‡ follow in the footsteps of Van Hise, distinguishing synclinorium and anticlinorium from geosyncline and geanticline, but using the former pair of words in the sense simply of compound folds. Geikie explicitly attributes to Dana the usage which he follows, but has apparently taken his definitions from Van Hise without referring to Dana's paper.

Chamberlin and Salisbury § have introduced a further confusion by treating synclinorium and anticlinorium as synonyms respectively of geosyncline and anticline.

It is, perhaps, too late to restore the words to their original sense, after they have been used in other senses by writers of so high authority. Yet such restoration seems very desirable.

The Overlap of the St. Stephens Limestone on the Lower Tertiary Formations in Crenshaw and Pike Counties, Ala.: EUGENE A. SMITH.

The paper described, with the aid of a map, a case of overlap of the Vicksburg limestone on the Nanafalia division of the lower Tertiary, where the former occurs in detached patches in the territory of the latter. The whole series of the intervening Tertiary formations outcrops between these isolated patches and the regular outcrops of the Vicksburg.

On the Jackson Anticlinal in Clarke County, Ala.: EUGENE A. SMITH.

A well defined anticlinal fold in Clarke County, Ala., shows some rather peculiar features of erosion and other phenomena which were described with the aid of an illustrative map.

Journal of Geology, Vol. 4, p. 319.

†Text-book of Geology, latest edition, pp. 678. 679.

‡Introduction to Geology, pp. 236–238.

§Geology, Vol 1, pp. 480, 481.

Erosion at Ducktown, Tennessee: L. C. GLENN.

Ducktown is situated on an old pene-plain now uplifted into a plateau, and thoroughly dissected so that the actual surface consists of slopes many of which are steep. It is a region of deep surficial rock decay, of heavy annual rainfall and of thick forest-covering under natural conditions.

The roasting and smelting of copper ores in the recent past has entirely destroyed the vegetation and left the surface perfectly bare. Surface erosion is rapidly removing the soil covering. The slopes are already deeply scarred with gullies only a few years old which are still rapidly growing.

The waste from the steep slopes has buried the former surface along the streamlets between them and is rapidly building up waste planes, so that neither slope nor narrow flood-plain is of any value for agriculture or grazing. Reforestation will be a very slow and difficult process.

Floods on these small streams rise higher and more rapidly than formerly and subside more quickly. During dry seasons some springs that were formerly perennial go dry and others almost cease flowing.

The case has peculiar importance as an illustration of not only the possibilities but the certain results of deforestation by man in other parts of the southern Appalachians, and of the need of adoption by the general government of a policy of forest preservation in these mountains.

The Hydrology and Geology of the Gulf Embayment Area of West Tennessee, West Kentucky and Southern Illinois: L. C. GLENN.

Unconsolidated deposits of Cretaceous or later age consist from below upward of Coffee, Rotten Limestone, Ripley, Porter's Creek, La Grange, Lafayette, Loess, Loam and Alluvium formations, the last four being surficial, but giving character in much of the area to waters from springs and shallow wells. Structurally the rocks dip gently from the edge toward the center of the embayment area.

The Coffee, Ripley and La Grange are water bearing and form one or more available sources of potable deep water over practically the entire region. The La Grange covers the greatest area and is most important. Deep waters are gotten at depths varying according to local conditions from 150 to 700 or 800 feet, the majority ranging from 200 to 400 feet. The water flows out at the surface in many cases and rises nearly to the surface in many others. The quality of the deep water is generally good. If any mineral matter is present it is apt to be a small amount of iron carbonate. Calcium and magnesium carbonate and sulphate may be present in some cases, usually in small quantities.

Increasing attention is given by the inhabitants of the region to these deep waters, and wells are sunk not only for corporate and industrial supply but for many private families. The beneficial effect of the deep water on the health of the users is marked.

The Skull of Syndyoceras: ERWIN H. BARBOUR.

A new fossil mammal, allied to *Protoceras* of the Oligocene and to the modern antelope, was discovered by the Morrill Geological Expedition of the University of Nebraska during the past season in the Loup Fork Tertiary of Sioux County, Neb. The skull of this genus, which has been named *Syndyoceras*, is characterized by two prominent frontal horns which curve inward and by two maxillary horns which rise from a common trunk and curve outward. The anterior horns divide the anterior nares into two parts, the posterior of which resembles a blow hole. The lower canines have become incisiform by migration, and likewise the first premolar has become distinctly caniniform.

The following abstracts were read by the secretary *pro tem.* in the absence of the authors of the papers:

The Keweenawan at Lake of the Woods in Minnesota: N. H. WINCHELL.

A visit in August, 1904, to the south shore of the Lake of the Woods, disclosed large areas of gabbro, apparently identical with that of the Keweenawan seen at Duluth and at other points in northern Minnesota.

An examination of specimens collected by J. E. Todd for the Minnesota Geological Survey, now in the museum of the University of Minnesota, warrants the assumption not only that this rock, under some shades of variation, occurs widely on the south shore of this lake, but also that it is associated with heavy basaltic rocks quite similar to the black basalts of the Lower Keweenawan, as well as with red granite.

This discovery, while correcting the prevalent idea of the "Laurentian" age of the rocks of the south shore of Lake of the Woods, indicates that the strike of the Kenweenawan from Duluth passes northwestwardly, and probably includes the outcrop of copper-bearing amygdaloid lately announced by the Canadian Geological Survey, occurring in the prairie at the north end of Lake Manitoba, where the strike of the formation is northwest and southeast.

Some Sink-hole Lakes of North Central Florida: E. H. SELLARDS.

The porous and very soluble limestone underlying the Florida peninsula has occasioned some unusual topographic features. Owing to the surface mantle of sand, the porous limestone and the general flatness of the country, a very small part only of the rainfall passes off as surface water, the greater part going at once into the ground. The dissolving effect of surface water is shown in the enlargement of stream basins through limestone. The solvent effect of underground water is indicated by numerous sink-holes throughout parts of the peninsula. By far the greater number of these sinks are small. Some, however, reach considerable size. All are more or less perfectly circular. In time the banks become less steep through decay of rocks, and the sink thereby enlarged. In limestone regions with little or no clay above, sinks often remain open at the

bottom, thus forming natural underground entrances for such rivulets or streams as drain to them. In regions holding some clay the sinks are likely to become permanently clogged and fill with water, affording a starting point around the sides for the hardwood species of plants. Occasional sink-holes occur of such size as to be entitled to mention as small lakes. Illustration of this kind of lake is taken from a series of sinks on the proposed university grounds at Gainsville. The largest of these spreads over something more than an acre. The banks are thickly clothed with the hardwood, or "hammock" types of vegetation, and while steep on one side are sloping on the other. The overflow in the rainy season is carried away by a small stream heading near the sink. The sink presents many of the features of a small lake, yet is not so old or so far developed that its sink-hole origin is not clearly evident. Small, circular, possibly solution, lake basins are exceedingly numerous in Florida. The "sink-hole" origin is assumed, however, to apply to a very few only of these.

Old Age in Brachiopods: H. W. SHIMER.

Brachiopod shells show old age along lines parallel to that exhibited by higher animals; when maturity is passed the tissues cease growing so rapidly and finally begin to shrink. As the mantle, the principal shell-secreting organ, shares in these states, it must express them in its growth. After a species has attained its fully mature size, which size varies in different individuals,the decreasing rate of growth is shown in the more or less sudden change in the angle of curvature from the beak to the front of the shell. This is followed in very old individuals by the development of a groove at the contact of the two valves, indicating that actual shrinkage of the mantle has occurred. Some of the other accompaniments of old age are the lamellose condition of the concentric growth lines, development of spines and nodes, and the thickening of the valves by internal addition, especially around the muscular impressions. Externally, old age characters appear first at the cardinal angles and advance progressively to the front of the shell.

Dipnoan Affinities of Arthrodires: C. R. EASTMAN.

By means of a new interpretation of the jaw parts of Arthrodires, which is here suggested, homologies are established between them and the corresponding elements of dipnoans. The arrangement of mylostomid dental plates is shown to be closely paralleled in early stages of *Neoceratodus*, and the functional lower jaw is similarly articulated with the head-shield. Intimate structural resemblances, not only as regards cranial characters, but throughout the entire organization, are brought out through comparison of Arthrodires with modern lung-fishes, and these are scarcely to be explained except on the theory of a common origin. All available evidence points to the correctness of Newberry's original interpretation of Arthrodires as armored dipnoans, a view which is not now commonly entertained. Their origin is traced through primitive ancestral ceratodonts to the elasmobranch stem, independently of crossopterygians.

The Great Catalogue of the Heber R. Bishop Collection of Jade: G. F. KUNZ.

The magnificent collection of jade which was made and presented by Mr. Heber R. Bishop during his lifetime to the Metropolitan Museum of Art, in New York, has been installed in a room which Mr. Bishop himself designed and had decorated by the noted firm of Allard Frères, of Paris, to make it the finest example on this continent of the style of Louis XV. The collection is here placed in some fifteen elegant cases, of gilt, bronze and plate glass, all in Louis XV style, which with the decorations of the room illustrate a permanence and richness of material never excelled even in the time of the artistic French monarch himself.

The catalogue which is the subject of this note is issued in two magnificent volumes, and is limited to an edition of one hundred copies, none of which goes to a private individual and none of which will be sold. These volumes (stately folios) are printed on the finest quality of linen paper, and weigh, respectively, 69 and 55 pounds, or 124 pounds together. They contain 570 pages (Vol. I, 277 pp., Vol. II, 293 pp.), measuring nineteen by twenty-five inches. There are 150 full-page illustrations, in the highest style of execution—water-color, etching and lithography—and nearly three hundred pen-and-ink sketches in the text.

No expense or care was spared in the execution of the work; some thirty scientific men and art specialists, both in Europe and in America, were engaged to contribute their views upon various aspects of the whole subject; and the illustrations were prepared in the finest manner possible, Chinese and Japanese artists being employed to execute many of them, and color experts being freely consulted, under the supervision of Mr. Bishop himself. The catalogue has, moreover, a special value from the fact that all the scientific investigations described therein were made upon material taken from the specimens in the collection itself.

This whole work, from its inception by Mr. Bishop in 1886 to the final distribution of the volumes, has required about twenty years, and was entirely planned and thought out by him. It is a cause of much satisfaction that the enterprise has been so fully and successfully completed along the lines which he laid down; but it is also a source of profound regret that he could not himself have lived to witness its final accomplishment. The whole cost has been met by the liberality of Mr. Bishop's provision, carried out by the care and thoughtfulness of his executors.

The foregoing account of the meeting has been prepared from the full notes kept by the secretary *pro tem.*

EDMUND OTIS HOVEY,
Secretary.

SECTION F.

ZOOLOGY.

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ADDRESS

BY

C. HART MERRIAM,

VICE-PRESIDENT AND CHAIRMAN OF SECTION F FOR 1905.

IS MUTATION A FACTOR IN THE EVOLUTION OF THE HIGHER VERTEBRATES?

The stir created among botanists and horticulturists by the recent work of de Vries, particularly by his Berkeley lectures (1904) on "The Origin of Species and Varieties by Mutation," has led certain zoologists to believe that species of animals as well as plants may arise by the sudden assumption of new characters. Thus Davenport, in a recent review, expresses the conviction that "as good an argument might be made from the zoological side as de Vries has made from the botanical." The promulgation of these views by so eminent a student of evolution as Davenport, in connection with the circumstance that more or less similar views are held by others, has led me to reexamine certain groups of birds and mammals, of which I had previously made systematic studies, for the purpose of discovering evidence, if such exists, of the formation of species by mutation.*

But first let us be sure of de Vries's meaning. He states that individual plants of a certain species of evening primrose which he kept under observation for a period of years, suddenly developed abnormal new characters or "qualities," and that these were inherited and gave rise to permanent new species,

*It is important that the terms used by de Vries should be understood What we systematists have been in the habit of calling spontaneous variations or "*sports*" he calls "*mutations*;" what we call "*individual variations*" he calls "*fluctuations*;" and what we call the "*characters*" of species he calls "*qualities*."

which continued to exist side by side with the parent species This process he calls "the origin of species by mutation." While admitting the extreme rarity of occurrences of this kind, he appears to have been carried away with enthusiasm over his discovery and jumps to the conclusion that species in general originate by mutation—and in no other way!

After stating that species "are not in the main distinguished from their allies by quantities nor by degrees; the very qualities may differ," he goes on to say that *if* the differences in quality can not be explained "by the slow and gradual accumulation of individual variation," and *if* the sudden variations called sports or mutations, "can be shown to occur in nature as well as they are known to occur in the cultivated condition, *then* in truth Darwinism can afford to lose the individual variations as a basis." Continuing the argument, he declares: "Then there will be two vast dominions of variability, sharply limited and sharply contrasted with one another. One of them (that of individual variation) will be ruled by Quetelet's law of probability and by the unavoidable and continuous occurrence of reversions. It will reign supreme in the sciences of anthropology and sociology. Outside of these, the other (that of sports or mutations) will become a new domain of investigation, and will ask to be designated by a new name"—the origin of species by mutation. There would seem to be no doubt as to de Vries's meaning. The question is, are his assumptions justified by the facts in nature? It will be observed that he deems the perpetuation of individual variations jeopardized "by the unavoidable and continuous occurrence of reversions." Let me ask in all seriousness if sport variations are less likely to disappear by reversion than are individual variations?

Let us now examine the "*if and ands*" of de Vries's argument The first of these is: *If* the differences in quality (characters) "can not be explained by the slow and gradual accumulation of individual variations * * *." May one venture to ask, Why can they not be so explained? Is it not true that up to the time of the announcement of his new theory a little more than a year ago, it was the practically unanimous belief of zoologists and botanists the world over that the differences in quality that go to make species do originate in precisely this way? And

has any reason been brought forward to justify—much less necessitate—a change in this belief? Are we, because of the discovery of a case in which a species appears to have arisen in a slightly different way—for after all the difference is only one of degree—to lose faith in the stability of knowledge and rush panic stricken into the sea of unbelief, unmindful of the cumulative observations and conclusions of zoologists and botanists?

De Vries's second and third *ifs* are : "*If* such strains (produced artificially among cultivated plants) can be proved to offer a better analogy to real systematic species, and *if* the sudden changes can be shown to occur in nature as well as they are known to occur in the cultivated condition, then in truth Darwinism can afford to lose the individual variations as a basis." The logic of this is hard to see, for is it conceivable that "strains," or varieties produced artificially among cultivated plants, "can be proved to offer a better analogy to real systematic species" than species produced in the normal way by the perpetuation of individual variations? "And if the sudden changes (sports or mutations) can be shown to occur in nature" —and I admit that they can—how does it follow that "then in truth Darwinism can afford to lose the individual variations as a basis?" Is not this a case of enthusiasm run wild? Is it not like arguing that if it can be proved that a man ate meat for breakfast, then of course he could not have eaten bread! To my mind the striking fallacy of de Vries's argument is his assumption that because it can be shown that sports occur in nature, and that in rare cases species arise therefrom, then the theory that species are produced by the progressive development of slight individual variations must be abandoned. Why can not species originate in both ways?

The occurrence of sports among animals and plants being admitted, the question arises as to what becomes of them. According to Darwin, Weismann, Dall, Jordan and a host of others they are lost by the swamping effects of interbreeding. That this is the usual result in both plants and animals I think every one will admit, for even de Vries frankly states that their perpetuation in giving rise to new species is so exceedingly rare that he is able to cite only a single authenticated case. I do not assume to be a botanist; nevertheless, for more than a quarter

of a century I have been an earnest field student of plants in their relations to geographic environment. These studies have convinced me that with plants, as with animals, the usual way in which new forms (subspecies and species) are produced is by the gradual progressive development of minute variations.

But we are not now concerned with plants. The question before us is, Do species among the higher vertebrates originate by the sudden acquirement of new characters? In seeking an answer I have passed in review more than a thousand species and subspecies of North American mammals and birds without finding a single one which appears to have originated in this way. Among the higher vertebrates, therefore, the conclusion seems justified that if species ever originate from sports, such mode of origin must be exceedingly rare. My own conviction is that the origin of species by mutation among both animals and plants is so uncommon that as a factor in evolution it may be regarded as trivial.

If species do not ordinarily originate in this way, it is fair to ask, How do they originate? My answer is, By the slow but progressive acquirement of characters that have their beginning in minute variations.

It is hardly necessary in the present connection to review the theories concerning the *inception* of variation, for whether or not we believe in the potency of dynamic influences, we all admit that individual organisms vary, and most of us are agreed that in the struggle for existence the beneficial variations are likely to be preserved, the harmful ones eliminated, by the action of natural selection. Some of us go further and believe that the universal and irrepressible tendency of organisms to vary results in the perpetuation, not only of distinctly useful departures, but sometimes also of those which, though not harmful, seem to be of not the slightest service to either the individual or the species. These, according to Dr. David Starr Jordan, owe their inception to geographic isolation. Dr. Jordan states: "The adaptive characters a species may present are due to natural selection or are developed in connection with the demands of competition. The characters, non-adaptive, which chiefly distinguish species, do not result from natural selection, but

from some form of geographical isolation and the segregation of individuals resulting from it. * * * Adaptation is the work of natural selection; the division of forms into species is the result of existence under new and diverse conditions." Jordan's view is that "the characters by which one species is actually known from the next are rarely traits of utility."*

This was Darwin's view also, for he says: "It is a strange result which we thus arrive at, namely, that characters of slight vital importance to the species are the most important to the systematist." T. H. Morgan goes even further, expressing his entire disbelief in the production of species through natural selection. Had he been familiar with the characters that distinguish many of our species of mammals, birds, and reptiles he could hardly have held this view, for while in some groups the characters naturalists make use of in defining species are mainly of the indifferent kind, in others they are largely of the adaptive and useful kind. Thus among mammals, birds, and reptiles, dozens of species and subspecies are distinguished from one another by adaptive characters alone. At the same time it should be understood that, as a rule, species are based *not on one but several characters*, some of which may be adaptive, others non-adaptive.

PRESSURE OF THE ENVIRONMENT.

Darwin's definition of natural selection or the survival of the fittest is: "The preservation of favorable individual differences and variations and the destruction of those that are injurious."

Whether a particular variation is beneficial or injurious depends of course on the environment. It follows that variations in order to be beneficial must be in harmony with, or meet demands of, the environment. Whether such adaptations should be attributed wholly to the slow action of natural selection, or whether one may be allowed to cherish the belief that the environment not only invites but compels variation, involves a distinction as important as it is difficult of demonstration. Is there not a hidden force which independent of, or superadded to, the general tendency of organisms to vary acts

*SCIENCE, N. S., Vol. XXII., p. 558, Nov. 3, 1905.

as an incentive in initiating useful variations? Have we not evidence of this in the increased length of toes and feet in species inhabiting soft or marshy ground; increased thickness of bills in birds that habitually crack seeds or nuts; increase in the length of canine teeth in mammals that catch and hold struggling prey; increase in the size of the carnassial teeth in mammals that crunch bones of other animals; special modifications of the feet to fit them for special purposes, as for wading, swimming or grasping; and also such variations as appear to result from prolonged and oft-repeated effort, as increased length of leg in species whose welfare depends on fleetness of foot, and greater development of the external ear, or greater complexity of the internal auditory apparatus which seem to be a consequence of long continued strain in listening for the approach of enemies or of prey? This subtle influence I like to call *the pressure of the environment*.

Dall was once bold enough to assert: "The environment stands in relation to the individual as the hammer and anvil to the blacksmith's hot iron. The organism suffers during its entire existence a continuous series of mechanical impacts, none the less real because invisible."* These are weighty words.

While a number of our ablest naturalists hold this view, the current feeling among morphologists and physiologists is undoubtedly against it. Thus Thomas Hunt Morgan in his book on "Evolution and Adaptation" (1903), says: "We can profitably reject, as I believe, much of the theory of natural selection, and more especially the idea that adaptations have arisen because of their usefulness."

Is not the fact that such diverse opinions are held by thoughtful men of science in itself an illustration of the pressure of environment? For is it not obvious—since those who spend their lives studying species in nature hold one view, while those who spend their lives peering into microscopes and inventing theories hold another view—is it not obvious that such antagonistic views are the outgrowth of different environments?

To those who admit the existence of dynamic influences it is conceivable that the inception of the resulting variations, as

*"Dynamic Influences in Evolution," W. H. Dall, *Proc. Biol. Soc Wash.*, VI, 2, 1890.

long ago pointed out by J. A. Allen, is not confined to a single individual, to be lost or saved by natural selection, but being the response of organisms to forces applied alike to all members of a species in a given area, takes place simultaneously in a large number of individuals and is thus established more quickly and with much greater certainty.

VARIATIONS.

It is convenient for the systematist to consider variations under four heads: (1) Fortuitous variations; (2) dynamic variations; (3) sexual variations; and (4) seasonal variations.

1. *Fortuitous variations* are such as arise without apparent cause—for it is in the nature of organisms to vary. They originate in a single individual, and occur everywhere, in all species of animals and plants. They may be beneficial, neutral, or injurious. The beneficial are likely to be preserved by natural selection and increased so long as the increase is beneficial to the possessor; the neutral may either disappear or persist; the injurious are promptly eliminated. According to degree of development at the time of their first appearance they may be designated *ordinary individual variations*, or *sport variations*. This is an old story.

2. *Dynamic variations* are such as arise, apparently, in response to pressure of the environment. They are necessarily beneficial, arise simultaneously in a number of individuals, and are cumulative so long as the increased development is helpful—that is, until a condition of equilibrium is established between the organism and the environment. They may be *functional* or *geographic*. Those that are functional may be *local* or *general*; those that are geographic may be *local* or *progressive*. Variations resulting from change of food habits, or from the necessity of coping with a new enemy, or from the too rapid spread of a species from one area to another, may progress to full maturity in a given locality; but in the case of ordinary geographic variations the change progresses laterally from one district to another. Thus in species that undergo geographic color variations, the change as a rule takes place so gradually that speci-

mens from adjacent localities may be hard to distinguish, while those from the two borders of the belt of intergradation may be markedly unlike. In this case the intergrades, as well as the extremes, are in complete accord with the surroundings, the members of the species at each step along the geographic line of intergradation having attained a state of equilibrium with reference to the environment at that point.

Usually the movements of animals and plants in acquiring new territory are slow, allowing time for the necessary adjustments to take place along the line of advance, so that no great change at any one locality is required. But it is conceivable that in certain cases the advance may be too rapid for this, bringing a species into an area to which it is not yet adapted, in which case the struggle for existence would be unusually severe and the development of adaptive characters would proceed with corresponding rapidity.

Illustrations of functional and geographic variation in the same animal are afforded by the kangaroo rats (genus *Dipodomys*)—a group of American mammals highly specialized for life on arid deserts. These animals have numerous enemies and a multitude of competitors, which means that the struggle for existence is always severe. They are of small size and have big heads, big eyes, small fore legs and feet, exceedingly long hind legs and feet, and very long tails. The long hind legs and tail are special adaptations for saltatory progression—for leaping instead of running. Another general functional character is the extraordinary development of the internal organ of hearing, which forms more than half of the bulk of the skull, enabling the animal to detect the approach of its mortal enemy, the soft-footed desert fox.

In addition to functional variations of this kind, which are general or common to the group, there are others that are local in character and confined to particular species or subspecies. Of these may be mentioned the increase in size of the hind foot in forms inhabiting soft or yielding soils—an adaptation that is even more marked in certain other groups.

Turning now from functional to geographic variations, we find in certain species a marked decrease in size from the

north southward. In *Dipodomys spectabilis*, which ranges from north-central New Mexico to southern Chihuahua—a distance of about 700 miles—the actual decrease in length is 52 millimeters (2 inches), or 14 percent of the total length. This is in accord with the general law of decrease in size from the north southward, announced by J. A. Allen many years ago.

The kangaroo rats furnish illustrations of still other matters of interest to the student of evolution. Passing the subject of color adaptations, of which much might be said, let us look for a moment at certain facts brought to light by a study of bodily proportions. Tabulation of the measurements of upwards of 500 adult specimens of the several species shows that individual variation is great, amounting in the hind foot to 15 percent, in the total length to 20 percent, in the length of tail to 24 percent—thus affording ample material for the evolution of new forms characterized by differences of proportion—but none such are developed. Indeed, the mean measurements throughout the genus are remarkably constant, the ratio of hind foot to total length varying only 2 percent; of tail only 4 percent. We have here a case of wide range of individual variation coupled with surprising constancy of proportions. What does this mean? It means, if I interpret the facts aright, that all the species of the genus *Dipodomys* have come to a halt along a common line, like soldiers in a well-drilled regiment, indicating that in the course of their evolution from a generalized to a specialized type they have already reached, with respect to the environment and mode of life, a state of equilibrium or equipoise from which any marked departure is injurious if not fatal. The possibilities in the way of divergence are shown by the large range of individual variation, which, however great, ceased long ago to operate in the production of new forms. All departures from the type are clearly disadvantageous and hence are promptly eliminated by natural selection. The operation of dynamic causes has resulted in the production of fixed conditions so far as the proportions are concerned—and no further modification need be looked for unless a marked change should occur in the environment.

SUBSPECIES.

It is obvious from de Vries's writings that his studies of plants have been mainly with species as modified by man rather than with species in a state of nature. For instance, he says: "The same original form can in this way give birth to numerous others, and this single fact at once gives an explanation of all those cases in which species comprise numbers of subspecies, or genera large series of nearly allied forms." In the present connection it is necessary to notice only two of the fallacies embodied in this sweeping assertion—the two concerning subspecies. As a matter of fact, subspecies in nature do not occupy the same ground with the parent form, but an adjacent area; hence it is hard to see how they could fulfill his geographic requirement, which is, that forms arising by mutation occur side by side with the original stock. And since subspecies differ from the parent form only by small differences, how can they arise from sports, which are distinguished from the parent form by large differences—differences of at least specific value?

From this it appears that de Vries's conception of subspecies and their relations in nature is somewhat hazy. In order to understand the relations and mode of origin of subspecies it is necessary to study them on the ground where they are formed, which means that it is necessary to consider them geographically. To do this intelligently one must study species in a region large enough to embrace belts of transition from one faunal (or floral) area to another, for it is in these transitional belts that the changes from one species or subspecies to another take place. The failure to recognize this simple but all important fact accounts for most of the current misconceptions concerning subspecies.*

*For present purposes it is immaterial whether subspecies are based on actual known intergradation (the point of view of the A. O. U. Code of Nomenclature) or on degree of relationship (the point of view of the morphologists and of some systematists), the material point being that they must be closely related to the parent form—either directly, or indirectly through other subspecies.

DO SPECIES ARISE INDEPENDENTLY OF GEOGRAPHIC ISOLATION?

According to de Vries: "We must conclude that new species are produced sideways by other forms, and that this change affects only the product and not the producer." Two of his seven "laws" relate to this phase of the subject. These are: "(1) New elementary species appear suddenly, without intermediate steps; (2) they spring laterally from the main stem (not replacing it)." In thus burdening his mutation theory with the additional requirement that in giving off new forms the old is not altered, but continues to exist side by side with the new, he restricts its application to an exceedingly small number of cases, thereby materially weakening the theory itself. For in the case of the birth of a new species the new quality or character may be either neutral or beneficial. If neutral—of no value to its possessor—it is conceivable that the resulting new species may continue to exist in the same area with the old; but if beneficial the new species in the struggle for existence will eventually destroy and supplant the old—unless it diverges geographically so as to inhabit a separate area.

Dr. D. S. Jordan has recently expressed the belief that well-defined species arise only as a result of geographic isolation, but I am not sure that he means by this just what the reader might infer. His words are: "It is now nearly forty years since Moritz Wagner first made it clear that geographical isolation was a factor or condition in the formation of every species, race or tribe of animal or plant we know on the face of the earth. This conclusion is accepted as almost self-evident by every competent student of species or of the geographical distribution of species." A little later he says: "The contention is not that species are *occasionally* associated with physical barriers, which determine their range, and which have been factors in their formation. It may be claimed that such conditions are *virtually universal*;" and again: "Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort."

J. B. Steere, in a paper on the distribution of birds in the Philippines, published in 1894, formulated the same idea in the following words: "No two species near enough alike structurally to be adapted to the same conditions will occupy the same area," and added that the facts "show *isolation* to be the first and the necessary step in the formation of species."*

I fully admit the potency of isolation in the production of species, but can not for a moment admit that *complete* isolation is a necessary factor in their evolution, mere *divarication* from a common center being in many cases sufficient. Neither can I admit that a barrier must be absolute, or that it must be interposed *between* species in order to be effective. This is proved in the case of climatic barriers, which, while not keeping contiguous species apart, nevertheless restrain each from trespassing far on the territory of its neighbor.

It is quite possible that Dr. Jordan's use of the word barrier, which occurs over and over again in his recent paper† is sufficiently elastic to cover most of the apparent discrepancies, so that the exceptions to his rule are really few. Still, there are in nature many groups of closely related species whose ranges follow one another in geographic series, the one beginning where the other stops, with no barrier of any kind between, as will be shown directly. In such cases it is often difficult to say whether the adjacent species have been established by differentiation from one another under existing geographic conditions, or have been developed from preexisting species along geographically divergent lines, and afterward have met by extensions of range. These points may be made clear by actual examples:

Among the kangaroo rats of the genus *Dipodomys* are two large and closely related species inhabiting our southern deserts. One of these, *D. deserti*, ranges from the Colorado and Mohave deserts in California easterly to a little east of Phœnix, Arizona; the other, *D. spectabilis*, from a little east of Phœnix to western Texas. The geographic division between the two is an invisible line a little southeast of Phœnix in a desert area devoid of barriers of any kind, even climatic. The case, therefore, appears to be an exception to the law of isolation.

*Auk, XI., 239, 1894.

†SCIENCE, NS., XXII., November 3, 1905.

Turning now to another group, illustrations of at least two kinds of variation among closely related species are afforded by the ground squirrels of the genus *Ammospermophilus*, of which three distinct species and three subspecies are recognized. These animals resemble one another in form and markings and in the habit of carrying the tail closely appressed against the back so that its under side is uppermost and is presented to the view of the observer. In one species the under side of the tail is dark; in the others white or nearly white. The three species and their geographic ranges are (see map, fig. 1):

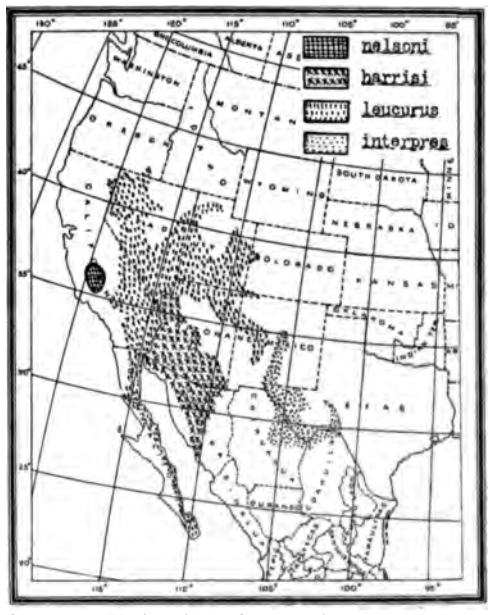


FIG. 1. Distribution of ground squirrels of the genus *Ammospermophilus*.

Ammospermophilus nelsoni, restricted to the hot southern end of the San Joaquin valley in California, where it occupies a detached area and is isolated by the encircling mountains, which by interposing a climatic barrier cut its range off from that of the parent species, *leucurus*. It has acquired a yellowish color which serves to distinguish it from all other members of the group.

Ammospermophilus harrisi, inhabiting the southwestern half of Arizona and extending south far into the state of Sonora; separated from its neighbor (*leucurus* and subspecies) on the west, north and east by two kinds of barriers—on the west by the absolute barrier of the Colorado river; on the north and east, along the southern edge of the Arizona plateau and its southerly continuation in New and Old Mexico, by the climatic barrier interposed by the elevation of the land.

Ammospermophilus leucurus, inhabiting the Colorado and Mohave deserts in California and thence, passing north of *harrisi*, ranging northerly and easterly over the Sonoran deserts of the Great Basin and easterly over northern Arizona to the Painted Desert and the Puerco, where it changes into subspecies *cinnamomeus*, which continues easterly to the Rio Grande valley near the center of New Mexico. On the opposite side of the Rio Grande (east of Albuquerque), another subspecies, *interpres*, begins and follows the Rio Grande southerly and easterly as far as the valley of the Pecos. A third subspecies, *peninsulæ*, occurs in the peninsula of Lower California. It thus appears that *leucurus*, including its subspecies, surrounds *harrisi* on three sides—west, north, and east—forming a complete horseshoe open only at the south. The nature of the barriers separating it from *harrisi* has been mentioned under the latter species.

Of the three subspecies of *leucurus*, two—*cinnamomeus* and *peninsulæ*—have the under side of the tail white and are only moderately accentuated color forms, continuous in distribution with the parent form and intergrading with it by imperceptible steps. The third subspecies, *interpres*, has some black intermixed in the white of the tail, and specimens from the El Paso region, where geographically *interpres* approaches nearest to *harrisi*, have more black than specimens from near Albuquerque, suggesting the possibility that intergradation may take place in the intervening area, in southwestern New Mexico. Unfortunately we have as yet no specimens from this area. If intergradation should be shown to occur, then we shall have an example of two well defined species occupying adjacent areas and intergrading at the point of contact while remaining dis-

tinct everywhere else. In other words the species are perfectly distinct wherever barriers exist separating their ranges, and intergrade where there are no barriers. In distribution and behavior, therefore, these animals conform to the usual rule, that closely related species separated by impassable barriers remain distinct, while those not separated by such barriers intergrade.

But the most significant and complicated case is that of the western chipmunks (genus *Eutamias*), one of the most elegant and attractive groups of American mammals. The genus occupies a vast area in western North America, extending from Lake Nipissing, Ontario, westerly to the Pacific Ocean, a distance of 2,000 miles, and from the Mackenzie river a little north of Great Slave Lake southward to the mountains of Zacatecas in Mexico, a distance of fully 3,000 miles. Most of the species dwell in forests, but a few inhabit the great sage brush plains. Faunally they contribute distinctive species to every life zone from the Upper Sonoran to the Arctic-Alpine. In mountainous regions the species are commonly distributed in parallel belts, the borders of which are not only in absolute contact, but even slightly overlap for long distances.

As it will be impossible in the time at our disposal to consider more than a few of the species, I have selected for illustration those that inhabit eastern California, along an east-and-west line extending from the west base of the Sierra Nevada to the summit of the White mountains. On the gradually rising slopes of the Sierra the species are arranged one above the other, from base to summit, in definite belts or strata (see diagram, fig. 2). Field studies have shown that these belts are the same as the transcontinental life zones, each of which is characterized by peculiarities of climate and by a definite association of species of mammals, birds, reptiles, trees and shrubs. There are no gaps between the belts, the upper border of one being coincident with the lower border of the next, so that individual animals of different species meet along the border lines of the several zones. In some cases only a single species inhabits a zone, but in one case not less than three occur together. These three however, as would be expected, are so

very distinct from one another that they could not possibly have arisen by mutation.

Beginning at the foot of the Sierra on the west side, the first species encountered is a large, dark,long-tailed form (*Eutamias merriami*), whose range coincides with the limits of the digger pine or Upper Sonoran zone. Immediately above this is the broad belt of ponderosa pines and giant sequoias of the Transition zone. The chipmunk of the zone below does not occur here, but is replaced by a striking long-eared species (*quadrimaculatus*) which fills the zone and is restricted to it. Along the line where the yellow pines of the Transition zone change to the

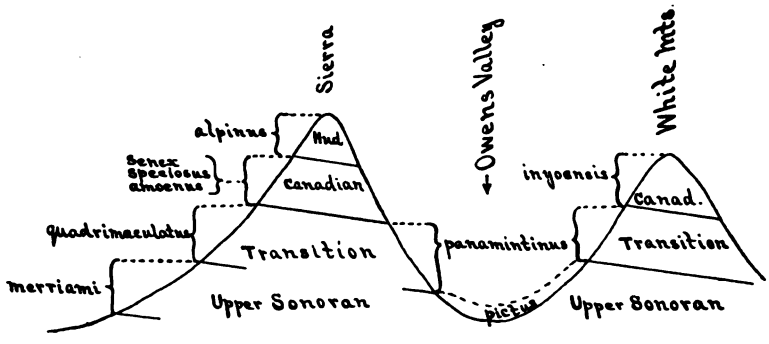


FIG. Diagram showing the Zone Ranges of chipmunks (genus *Eutamias*) in an east-west section of the middle Sierra and White mountains in Eastern California.

Murray pines of the Canadian, no less than three species (*amœnus*, *senex* and *speciosus*) begin abruptly and range upward throughout the Canadian zone. Above this still is the Hudsonian zone, and it also has its distinctive chipmunk—a small but highly colored species (*alpinus*)—which fills the zone completely and climbs up a short distance on the alpine slopes above timber line. Crossing the summit and descending the steep east side of the Sierra, the Canadian zone is found to be inhabited by the same three species that occupy this zone on the west slope. Below this, in the nut pine belt of the Transition zone, is a brilliantly colored species (*panamintinus*) very different from any we have seen. Still lower, in the Upper Sonoran sage brush of Owens Valley, is a small gray species (*pictus*) not re-

lated to any of the others. Owens Valley is a long narrow and deep valley between the Sierra and the White mountains. Crossing this valley and ascending the west slope of the White mountains we reenter the nut pine belt and find the same chipmunk (*panamintinus*) that we found in the same belt on the other side of the valley (on the east slope of the Sierra). Continuing the ascent we enter the Canadian zone, which covers the greater part of the summit of the White mountains, and in it find a widely different chipmunk (*inyoensis*), which proves to be another member of the beautiful *speciosus* group—a group we have already found represented in the same zone on both east and west slopes of the Sierra.

Thus in a distance of a hundred miles, from the west base of the Sierra to the summit of the White mountains, are included the ranges of no less than nine species of chipmunks. This is made possible by the height and steepness of the mountains, the abrupt changes in altitude with consequent differences in temperature compressing the life zones into narrow parallel belts; whereas in level regions, as well known, these same belts are spread out broadly over the land.

The Sierra chipmunks furnish striking illustrations of the *occurrence* of species without isolation, and some of them of the *evolution* of species without isolation, for not only are there no visible barriers between the ranges of adjoining species, but the species themselves actually overlap along the zone borders, individual animals belonging to the zone above and the zone below occurring together on the same ground. But while there are no barriers *between* the species, each belongs to and is characteristic of a definite climatic life zone, and the fact that the life zones overlap slightly along the edges explains the slight geographic overlapping of the species themselves. The reason the species do not intergrade along the lines of contact doubtless is that they are not closely enough related—their differentiation into fully developed species (with the probable exception of *speciosus* and *inyoensis*) having taken place long ago.

The question now arises as to the origin of the nine species Most of these, if studied independently of their relations in other parts of the country, resemble one another sufficiently to

justify the inference that they have been derived from one another.

Far from holding this view, however, my belief is that some of them came from closely related forms in remote geographic areas, others from antecedent forms now extinct, and not more than three or four from species still inhabiting the region. The case is of a class often encountered by the systematist and student of distribution, where without a comprehensive knowledge of the relationships and geographic distribution of the group as a whole and of its component species and subspecies, there is little hope of arriving at correct conclusions. Let us look closely at the facts, for they have an important bearing on more than one problem in evolution and distribution.

The Hudsonian species *alpinus*, now restricted to the lofty crest of the southern High Sierra, appears to be distantly related to *oreocetes* of Montana, but has no near relative.

Another of the Boreal species, *amœnus*, ranges northward over the Cascades in Oregon and is only subspecifically distinct from a form inhabitating the boreal forests of the Rocky mountains in Colorado.

The *speciosus* group, it will be remembered, is represented in the east California section by two forms (*speciosus* and *inyoensis*), which may be called species or subspecies, as you like—the fact being that they are more closely interrelated than are any of the other forms of the region, although intergradation has not been proved. But instead of occupying different faunal zones, as do the other species, they occupy different parts of the same zone—*speciosus* inhabiting the Boreal slopes of the Sierra, *inyoensis* the corresponding Boreal crest of the adjacent White mountains (here separated from *speciosus* by the Upper Sonoran and Transition zones of Owens Valley). But where did the *speciosus* type come from? Investigations carried on by the Biological Survey show that the same specific type still inhabits the upper slopes of the San Bernardino and San Jacinto mountains in southern California; that a more distantly related form (*quadrivittatus*) occupies the Transition zone in Colorado; and that between the two, on an isolated mountain peak rising from the arid deserts of southern Nevada, is another species

(*palmeri*), more strongly differentiated in consequence of local peculiarities of environment. These facts show not only that the *speciosus-quadrivittatus* group is a very old one, but also that its ancestors once inhabited the Great Basin itself. In those days the arid deserts of this region were in their infancy and must have been completely bridged by continuity of coniferous forests, connecting the Sierra and Rocky mountain areas.

The Desert Range species, *panamintinus*, which occupies the Transition zone on both sides of Owens Valley, occurs south of the White and Inyo mountains in the Coso and Argus mountains, and farther east, in the Panamint, Grapevine, Providence and New York mountains in the desert region of eastern California, and on Mount Magruder in western Nevada. It belongs to a group of which only one other species is known—*hopiensis*, of the high desert mesas of northeastern Arizona, southeastern Utah and southwestern Colorado. In this case, as in that of two other groups already discussed (the *amœnus* group and the *speciosus-quadrivittatus* group), the range of the type comprises localities on both sides of the Great Basin. The *panamintinus-hopiensis* group appears to be an aberrant offspring of the *speciosus-quadrivittatus* group and probably originated from the ancestors of that group in the by-gone days when they inhabited the ancient forests of the Great Basin.

Eutamias senex appears to have originated in the Siskiyou mountains, on the boundary between California and Oregon, as an offshoot from the redwood chipmunk, *ochrogenys*—which in turn is closely related to *townsendi* of the northwest coast of Oregon and Washington. From the Siskiyous, *senex* ranges north along the Cascades nearly to Mt. Hood, and south in the Sierra to the latitude of Yosemite Valley. In time it may be expected to push on to the south end of the Boreal Sierra in the Mt. Whitney region. *E. senex* appears to be the parent form, directly or indirectly, of two other species—*quadrimaculatus* and *merriami*—whose ranges now occupy considerable stretches along the flanks of the Sierra. It seems probable that *quadrimaculatus* originated near the north end of its present range and under existing geographic and climatic conditions. While as we have already seen, it occupies the Transition zone, directly

below the Boreal zone inhabited by *senex*, and while the ranges of the two are in direct contact for many miles, both species remain true, showing no tendency to intergrade. The history of *merriami* is by no means so simple, and the road by which it reached its present home by no means so direct. It is not an immediate offshoot from *senex*, for before attaining its present status it passed through another form, known as *pricei*. The story, as I interpret it, is this: In the northern part of California, south of the Siskiyous and west of the northern Sierra, the Boreal *senex* gave off a Transition zone form which spread and became differentiated in two directions: to the southward along the west flank of the Sierra it developed long ears and the peculiarities of coloration that distinguish *quadrimaculatus*; to the westward it developed the long tail and other peculiarities that distinguish *pricei*. The latter pressed southward through the coast ranges to Monterey Bay, south of which it underwent another change, assuming the characters by which *merriami* differs from *pricei*, and continued in the same direction to the Santa Barbara mountains, and then easterly to Mt. Pinos, where its range forked, the north branch following the Tejon and Tehachapi mountains to the southern Sierra and thence northward to a little beyond the Yosemite; the south branch pushing southeasterly over the Sierra Liebre, Sierra Madre, San Gabriel and San Bernardino mountains, and thence south over San Jacinto and Palamar to the San Pedro Martyr mountains of Lower California. In the Sierra region *merriami* is restricted to the Upper Sonoran zone, while its immediate ancestor, *pricei*, belongs to the Transition zone, and its remoter ancestor, *senex*, to the Boreal zone. The change from Boreal *senex* to Transition zone *pricei* and *quadrimaculatus* is merely a zone adaptation to an immediately adjoining area; the change from *pricei* to *merriami* is simpler and at the same time more interesting, for the belt occupied by *pricei*, while mainly Transition, possesses the climatic peculiarity of mild winters and relatively cool summers and fulfills the temperature requirements of both Transition and Upper Austral zones, permitting an overlapping or admixture of the distinctive species of both. In this belt *merriami* became adapted to Upper

Austral conditions, so that in extending its range back to the Sierra it was natural that it should adhere to the Upper Sonoran zone.

The three Sierra members of the *senex* group (*senex*, *quadrimaculatus*, and *merriami*) therefore have reached their appropriate zones from opposite directions—*senex* and its offshoot *quadrimaculatus* from the north by direct continuity of range; *merriami* from the south (after passing through another form) by the roundabout way of the Coast ranges and the Tejon and Tehachapi mountains.*

To sum up the story of the California chipmunks from the standpoint of their geographic origin: Of the nine species inhabiting the middle Sierra region, six (*senex*, *amœnus*, *speciosus*, *merriami*, *panamintinus* and *pictus*) appear to have come in from contiguous territory in their present condition—as fully formed species— although it is possible that one of them (*amœnus*) originated here and extended its range northward; and three (*quadrimaculatus*, *inyoensis* and *alpinus*) appear to have been developed within the region in the areas they now inhabit. So far as origin is concerned, therefore, we have to do with only the last three. Of these, one—*inyoensis*—was clearly derived from the *speciosus* stock by the gradual accentuation of minute variations; another, *quadrimaculatus*, appears to have originated from *senex* in the same way, as already explained, leaving only one, *alpinus*, whose history is by no means obvious. Since *alpinus* has no near relatives, there is little in the way of a clue to its ancestry. As already suggested, it may be the remnant of an Arctic-Alpine group, of which it and *oreocetes* of the high mountains of western Montana are the sole survivors. In any case its origin must be sought far back in the past.

I have dwelt thus at length on the California chipmunks for

*The chipmunks afford admirable illustrations of a number of phases of variation and distribution besides those here discussed—as the occurrence of closely related forms end-to-end in the same zone; the spreading out of a species in certain parts of its range to cover an adjacent zone which elsewhere is avoided; the development of protective and directive coloration and markings; the utility or non-utility of characters used in the discrimination of species, and so on.

three reasons: (1) The problems they present to the student of variation and evolution are fairly representative of problems presented by other groups; (2) the compact distribution of the species in close-lying parallel belts in conformity with the life zones has the advantage of bringing them into near relations, so that the facts of variation and behaviour are easily discerned; (3) the study of the group emphasizes the necessity of a knowledge of the geographic distribution of species in order that their interrelations and probable origins may be understood.

The term geographic distribution must not be taken to mean merely the area a species occupies, to be shown by a color patch on the map, but includes a comprehensive knowledge of the geographic environment, taking into account the climate and the aspects of nature with which each species is associated and by which it is profoundly impressed. Moritz Wagner, in a paragraph recently quoted by Doctor Jordan, said: "It is the study of all the important phenomena embraced in the geography of animals and plants, which is the surest guide to the study of the real phases in the process of the formation of species." To the systematist and student of evolution this knowledge is so fundamental that it is hard to see how correct conclusions can be reached without it. In studying problems in nature the geographic point of view is the natural method of approach; it is a method so full of suggestions and explanations that we can ill afford to do without it. And how can it be otherwise, for do we not all admit that organisms are profoundly affected and modified by their environment? The utter hopelessness of attempting to work out the variations, affinities and probable origin of a group of related species of animals or plants without giving heed to the geographic distribution of the various forms, has just been illustrated by the case of the Sierra chipmunks. For several of them, it will be remembered, resemble one another so closely as to lead one to believe them much more closely related than they really are, and to suspect the origin from one another of species which, as a knowledge of their distribution shows, really originated in remote areas and came into juxtaposition in the Sierra after slowly traveling hundreds of miles by diverse and sometimes tortuous routes. If to a knowledge of the present distribution of a group can be added a few facts

from its paleontological history, a flood of light is at once thrown on the problem of the origin of its species.

INTERGRADATION AND REGIONAL INFLUENCES.

In studying geographic variation in the various groups of terrestrial animals and plants one soon learns that among related species and subspecies some forms intergrade while others do not; and that among those that do intergrade, the change from one to another may take place abruptly in a narrow belt, or gradually, by imperceptible steps, over a wide area. These two kinds of intergradation do not usually occur in the same area, for the reason that each is associated with a definite set of geographic and physiographic conditions of which climate plays the most important part. As a general rule it may be asserted that where the geographic change from one faunal area to another is gradual, the change in the species is gradual; and conversely, where the geographic change is abrupt the change in the species is abrupt. Changes in a north-and-south direction are likely to be gradual; those in an east-and-west direction are likely to be more abrupt. In both cases, the controlling power of environment is easily recognized. It follows that one species does not change here, another there; the rule—to which there are exceptions—is that all change in a common belt or area. It thus comes about that American students of species, from Baird's time to the present, have learned to recognize certain geographic areas, usually in the form of belts, where the transition from one set of animals and plants to another set takes place. These belts of intergradation, broad or narrow as the case may be, are always flooded with intergrades, which, though the bane of the museum man, are of great importance to the student of variation and evolution.*

*Of the belts of this kind are the overlapping boundaries of the life zones and certain other lines which mark the change from one physiographic or physiognomic type to another. Among these may be mentioned a strip along the western edge of the deciduous forests, where woodland gives place to prairie; a belt near the ninety-ninth meridian, where the humid prairies change to the arid plains; a belt along the east base of the Rocky mountains, where plains forms change to mountain forms; and similar or corresponding areas in the Great Basin and in the interior of California.

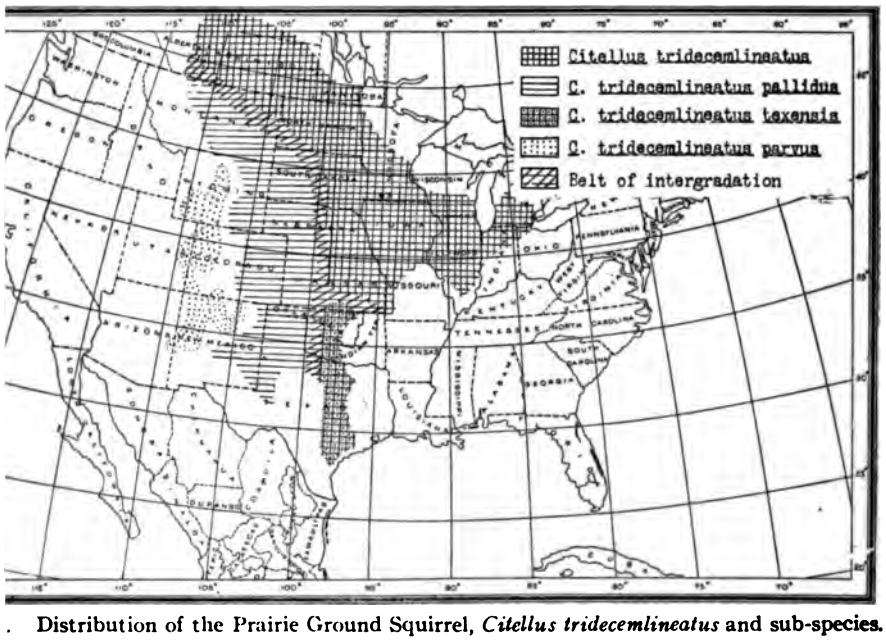
In order to make the matter perfectly clear—for it is one of no small importance to evolutionists—let me cite a few examples.

The common prairie ground squirrel or striped spermophile (*Citellus tridecemlineatus*) spilts up into four geographic forms or subspecies. The range of the species as a whole extends from the plains of the Saskatchewan on the north to the coast of Texas, and from the extreme eastern edge of the prairie country in the Great Lake region westerly to and a little beyond the Rocky mountains (see map, fig. 3). Typical *tridecemlineatus* occupies the eastern and more humid part of this area. In ranging westward it undergoes a change, becoming paler and smaller as it enters the arid plains. The change occurs between the one-hundredth and one hundred and first meridians, from South Dakota to middle Texas, and the resulting pallid form (subspecies *pallidus*) continues westerly to the foot of the Rocky mountains. In passing southward from the Upper Austral to the Lower Austral zone *tridecemlineatus* develops another form (subspecies *texensis*), which occupies a broad belt in Oklahoma and eastern Texas, east of the range of subspecies *pallidus*. But this is not all, for the plains form (*pallidus*) in pushing westward over some of the passes of the Rocky mountains gives off still another subspecies (*parvus*), which occupies the Green River Basin in Wyoming, and extends thence southerly in an irregular and interrupted belt along the border between Colorado and Utah, and occurs in isolated colonies in New Mexico and extreme eastern Arizona. Between these several forms are the belts of intergradation, as shown on the accompanying map (fig. 3).

The case is one in which a well-marked species splits into four geographic forms or subspecies in conformity with the climatic and physical features of the region inhabited. Each form is fairly constant throughout the major part of its range and develops intergrades in the transitional belt between it and the next form.

Among North American mammals and birds there are hundreds of such cases; indeed more than 1,000 species and subspecies, connected with other forms by series of intergrades, might be enumerated.

It may be set down as a general law that wherever a species or subspecies passes into another, intergrades occur, not side by side with the typical form, but replacing it in the territory between it and that occupied by the new form, so that as a rule all the individuals from the transitional territory are intergrades. This fundamental fact in geographic biology seems to have escaped the keen eye of Darwin, who, in speaking of the difficulties and obstacles in the way of his theories, said:



Distribution of the Prairie Ground Squirrel, *Citellus tridecemlineatus* and sub-species.

"Why, if species have descended from other species by fine gradations, do we not everywhere see innumerable transitional forms? Why is not all nature in confusion, instead of the species being as we see them, well defined?" One of his critics, Thomas Hunt Morgan, thinks this a very serious matter. My reply to both Darwin and Morgan is that they are mistaken in their premises, for in nature transitional forms are so abundant as to be a source of annoyance and embarrassment to systematists and museum curators—men who are continually handling specimens which they desire to refer to one species or

another. The only explanation I think of to account for Darwin's and Morgan's failure to recognize this fact is limited or unfavorable field experience, and limited experience in handling specimens from the peripheries of geographic areas large enough to cover the transition from one faunal division into another—in other words, failure to study the behavior of species in nature from the geographic standpoint. One might spend a lifetime in studying animals and plants in the interior of almost any of the faunal areas without encountering transitional forms or intergrades, for it is at the peripheries or borders of these areas that the intergrades occur. It would seem, therefore, that Darwin, in his effort to present fairly all objections to his theory, imagined a difficulty which does not exist, and that his critic Morgan solemnly shook his head at a man of straw.

Conclusion.—Inasmuch as all species have their beginnings in variations, and inasmuch as sudden or sport variations are exceedingly rare while slight variations are exceedingly common, does it not follow that the vast majority of species must originate from slight variations? My argument is not that species of plants may not in rare cases arise by the perpetuation of sport characters, as de Vries believes they do, but admitting this, my contention is that the overwhelming majority of plants, and so far as known all animals, originate in the generally recognized way, by the gradual development of minute variations. The theory of the origin of species by mutation, therefore, far from being a great principle in biology, as some seem to believe, appears to be one of a hundred minor factors to be considered in rare cases as a possible explanation of the origin of particular species of plants, but so far as known not applicable in the case of animals.

Note.—Lest I be misunderstood, I wish to record my appreciation of the splendid work de Vries has done in horticulture and plant breeding. His error lies in failure to recognize the all-important fact that species of plants and animals under man's influence behave quite differently from species in a state of nature. Thus, under man's selection hybrids have been produced in great numbers. But nature abhors hybrids—and well she may, for did species hybridize freely under natural conditions the entire superstructure of organic nature would be speedily destroyed.

REPORT OF THE SECRETARY OF SECTION F.

On the afternoon of December 29 the vice-president's address was delivered by C. H. Merriam, on the subject, "Is Mutation a Factor in the Evolution of the Higher Vertebrates?" The section met for the reading of papers on December 30, and joint sessions were held on January 1 with the Section of Physiology and Experimental Medicine, and on January 2 with the Association of Economic Entomologists. The following papers were read before the section:

Preliminary Observations on the Variation of Utethesia venusta, Dalman: MEL. T. COOK, Santiago de las Vegas, Cuba.

The literature recognizes three species (*U. bella, U venusta* and *U. ornatrix*) and three varieties (*hybrida, terminalis* and *stretchii*) of this genus. These species cover a very wide range. The distinctive characters are primarily color characters. After examining a large number of specimens, many of which were reared in captivity, the writer concludes that intergradations are such as to reduce these three species and three varieties to one species.

Filaria loa, a Study on the Dispersal of Parasites: HENRY B. WARD, University of Nebraska.

Of the African eye worm (*Filaria loa*) the author has recently published a list of 86 old and 8 new cases. The first six cases on record were from the West Indies, as also twelve in the first 21. But since 1845 no cases have been recorded there, its introduction having ceased with the cessation of the slave trade. All cases were in negroes and most had recently come from West Africa. Five cases reported from France all originated in the French Congo, as also cases from Switzerland and Belgium. One specimen removed in Germany came from Kamerun, and five in England from Old Calabar.

Eight cases in North America since 1890 were all in missionaries and all but one came from Kamerun. Thus all extra-African cases are distinctly traceable to a known or a possible infection in the western part of that continent where the parasite is endemic. Here the review of cases indicates clearly that the parasite is distributed over the entire coast from about 5° north of the equator to at least 10° south, and various observers say that in certain regions nearly every inhabitant suffers from it. This is recorded for the Ogowé River by Miss Mary Kingsley, the well-known African traveler.

How far it may penetrate into the interior of the continent is as yet unknown. Certain it is, however, that cases occur more than 120 miles

from the coast, while a recent paper records its presence in a post-mortem made in Kassai, approximately 600 miles from the coast on one of the chief tributaries of the Congo.

The occurrence of *Filaria loa* in negro slaves, in travelers, in government officials and in missionaries points out distinctly the certainty with which any kind of intercourse between nations and geographic areas tends to transfer to new races and territories the diseases of the old. Increased means of communication and growing freedom of movement contribute clearly to the spread of maladies and call for better means to check their advance into new regions It is not to be doubted that some of the persons who brought *F. loa* into the United States now harbor its embryos in the blood. Though we know nothing precise of its life history, the possibility lies close at hand that some blood-sucking insect may furnish these embryos proper conditions for further development and may thus bring about the introduction of a new disease into our territory. Such cases as these of *F. loa* show clearly the gradual spread of disease through national intercourse.

A New Bothriocephalid Parasite of Man: HENRY B. WARD, University of Nebraska.

The specimens were obtained from a child six years of age, born and brought up in the prairie region. The report of the mother that the child had been found some months ago chewing a piece of raw fish probably serves to explain the mode of infection. The specimens do not belong to the common bothriocephalid found in man (*Dibothriocephalus latus*), but to another species apparently undescribed as yet. A complete account of the anatomy of the species will be published later, together with a discussion of its relationship.

An American Species of Lumbriculus Grube: FRANK SMITH, University of Illinois.

The species, *Lumbriculus variegatus* (Müller) is the best known representative of the family Lumbriculidæ and is the only recognized member of its genus. It has thus far been found only in Europe. Recent papers by Wenig and Hesse have extended our knowledge of the reproductive organs of that species and have lessened the supposed differences between it and *Thinodrilus inconstans* Smith, described in 1895 from Illinois specimens. After a further study of these specimens, the writer is convinced that the Illinois specimens should be included in the genus *Lumbriculus*. The details of structure and comparison on which this conclusion is based appear in the paper which will soon be published in the Bulletin of the Illinois State Laboratory of Natural History.

A Mendelian Character in Cattle: W. J. SPILLMAN, U. S. Department of Agriculture.

The data presented indicate that in crosses between polled and horned cattle the inheritance of the horn-producing character is in accordance

with Mendel's well-known law of segregation of character pairs. The paper was based on the progeny of seven polled bulls bred to horned cows. The polled character is dominant, though the hybrids frequently have "scurs" —imperfectly developed horns.

The Activity of the White Rat at Different Ages: JAMES ROLLIN SLONAKER, Stanford University.

Three preliminary experiments have been carried on and others are in progress to determine the normal daily activity of the white rat from birth to natural death due to old age. The rate of growth as determined by weight, and the daily activity as determined by the number of revolutions of revolving cages are carefully recorded and tabulated. From the preliminary experiments the following conclusions may be drawn:

1. A marked difference in daily activity is noticed in rats of different ages.

2. The very young rat and the old rat are each noticeably inactive.

3. The period of greatest activity appears to be when the rat has reached the age of 100 days. At this age the weight is but little more than half that of the adult.

4. The period of daily activity occurs almost wholly during the night-time. They show little or no activity during the day-time. This, I think, is due mainly to the anatomical structure of the eye and to inherited tendencies.

5. The curve of activity rises gradually until the rats have reached about the age of forty or fifty days, after which there is a very rapid ascent.

6. Great individual variations are manifested, which necessitate experimenting on a larger number of individuals.

7. Owing to the premature termination of these preliminary experiments, a curve representing the activity from birth to death due to old age could not be constructed. Experiments now in progress will furnish the data for such a curve.

The Physiological Effects of Changes in Water Density and Salinity on Fishes: F. B. SUMNER, College of the City of New York.

The Poison Glands of Noturus and Schilbeodes: H. D. REED, Cornell University.

The Osteology and Relationships of the Percopsidæ: H. D. REED, Cornell University.

Descriptions of a New Genus and Nine New Species of Sphæromidæ: HARRIET RICHARDSON, Smithsonian Institution.

In this paper a number of new species belonging to several well-known genera are described, and diagnoses of genera heretofore established are more fully drawn up, together with the definition of a new genus, *Cassi-*

dias. The species described come from off Cape St. Roque, Brazil; off Rio de la Plata, Argentine Republic; from Hakodate Bay, Japan, and Cape Town, Africa. The types of all are in the collection of the U. S. National Museum. A few remarks are offered in regard to the species of the genus *Tecticeps* and both *T. alascensis* and *T. convexus* are redescribed and additional figures given.

The Embryology of Corymorpha: HARRY BEAL TORREY, University of California.

Fertilization is external; the eggs are amœboid until fertilized. Cleavage is approximately equal. The gastrula cavity is formed between the cells of a solid endodermic mass of planula. The latter is never ciliated and has no free-swimming stage, but may creep slowly. The hydranth is formed by a *transformation* of the distal half of the embryo; the axes of the tentacles arise from cells pushed out from the epithelial endoderm. Rootlets appear similarly. Tentacles arise according to a modified quartet plan governed probably in large measure by mechanical conditions. Cœnosarcal canals, numerous in the adult, are derived from a single larval cavity by ingrowth and enlargement of epithelial endoderm cells. Morphallaxis plays an important rôle in development.

The Relation between the Nerves of Taste and Touch in Fishes: C. JUDSON HERRICK, Denison University.

It has been shown that certain teleosts, notably catfish and carp, are provided with taste buds freely distributed in the outer skin, that the fishes taste with these organs and habitually localize their food by the combined action of cutaneous organs of touch and taste. Inasmuch as these sense organs belong to totally distinct systems (somatic and visceral, respectively) whose peripheral nerves and primary cerebral centers are wholly unrelated, considerable interest attaches to the question of the central relations of the tactile and gustatory systems of neurones with one another. The gustatory reflex paths within the brains of these fishes have been fully worked out, and the present paper reports the discovery of a broad and complex area of correlation with the tactile centers in the funicular nuclei at the lower end of the medulla oblongata.

The Problem of Wing Origin and its Significance in Insect Phylogeny: HERBERT OSBORN, Ohio State University.

The origin of the insect wing is a difficult problem to solve, since on account of its antiquity the evidence, both morphological and developmental, is much obscured. Fossil forms show the occurrence of winged insects as far back as the Paleozoic, and the structure must, of course, have arisen at some time prior to or during that period. The reduction of types of venation to a common form indicates a common origin for wings of all orders, and the inclusion of tracheæ suggests a respiratory function. A

respiratory function indicates aquatic life in the ancestral form, a suggestion which is corroborated by the method of musculature and the development so far as it can be traced. That they are not to be associated with any existing forms of aquatic insects is believed to be shown by the secondary character of aquatic adaptation of modern orders. The explanation of aquatic origin becomes conceivable, however, if we assume a primitive tracheate form, perhaps peripatoid in character, which became adapted to aquatic life before or during Paleozoic time, this primitive aquatic form returning to terrestrial habit and the tracheated respiratory gills being modified to wings. Of the existing orders then arising, some have become in part or quite entirely aquatic by adaptation in more recent time. Diagrams indicating the appearance of the different orders of insects in time and their lines of derivation as suggested by this conception of the evolution of the Pterygota were shown.

C. HUDSON HERRICK,
Secretary.

SECTION G.

BOTANY.

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ADDRESS

BY

B. L. ROBINSON,

VICE-PRESIDENT AND CHAIRMAN OF SECTION G FOR 1905.

THE GENERIC CONCEPT IN THE CLASSIFICATION OF THE FLOWERING PLANTS.

That many of the most useful scientific terms defy accurate definition is a fact which can not be denied. Indeed, the recent progress of science, at least in biology, has been away from, rather than towards, any dogmatic form of statement. Many terms, which, fifty years ago were smugly defined in the text-books and manuals of the time, are now, when viewed in the light of the developmental theory and from the diverse points of view of modern investigation, either well-nigh obsolete or have, through a gradual accretion of varying meanings, come to express only the vaguest generalities. This change is by no means a matter to be deplored. It is, in fact, an evidence of advancing thought. Loose and general terms are giving place to more technical and specific ones at about the same rate that the older and vaguer concepts are being supplanted by the more refined distinctions of modern science.

In some cases, however, the wide usefulness and general familiarity of terms have made them, notwithstanding some vagueness, far too valuable to discard and difficult to replace; and in these cases it is a matter of great importance that scientists should from time to time examine such terms theoretically in order that they may be applied with reasonable uniformity. An excellent example in point is the word *genus*, so well known

yet so variously used. It is in no wise my purpose in the course of these remarks to attempt to redefine the generic concept, but merely to consider the present divergence in the limitation of genera and see if there is any practical basis for a greater harmony in this matter.

Plants are classified according to their degrees of likeness or dissimilarity to each other. In likeness we see evidence that certain plants are related, and by related we mean that they are sprung from a comparatively recent common ancestry. Likeness , it is true, no matter how close it may be, is not an absolute proof of near relationship; but, since in most cases it is impossible to trace conclusively the ancestry of existing species of plants, their degree of similarity furnishes almost the only evidence available in regard to their relationship. I need scarcely say that by likeness is here meant not mere habitual resemblance, but the sum of all the morphological, anatomical and physiological similarities between the plants compared. Bearing these matters in mind, we may roughly describe a genus (when pluritypic) as a group of species which from likeness appear to be more nearly related to each other than they are to other species. But so varying are the degrees of similarity and so diverse is human judgment regarding them, that such a definition offers only an exceedingly vague basis for a uniform classification.

Indeed, the practice of different botanists in the interpretation of genera has been so multifarious that many persons have become skeptical as to the real existence of such groups in nature, and are accordingly inclined to treat the whole subject of generic classification as a mere matter of utility, a sort of division of the plant world into sections of convenient size by confessedly artificial lines analogous to the parallels of latitude and meridians of longitude. But much may be said for the objective reality of genera, at least in certain families. Who will wish to contend, for instance, that such tolerably uniform groups as *Lupinus*, *Aquilegia*, *Delphinium* or *Carex* are not far more distinct natural categories than are many of the relatively vague and ill-defined species of which they are composed? There can be no doubt whatever that in many

families clearly definable genera exist and have been duly recognized. In other families or parts of families, however, the living species do not fall into sharply limitable groups, but are by character either somewhat isolated or more often exhibit highly complex cross affinities rendering any simple or convincing classification into genera impossible. It is in such groups that uniformity of classification is most difficult to obtain, for it is in them that individual judgment has the widest play.

There are two very different methods of treating genera. One is to lay much stress on the idea of a generic type, that is to say, a species of the genus in question, which is supposed to fix the generic character and pass as a sort of sample or gauge, by comparison with which other nearly related species are to be judged. If they appear to agree with this type-species in the essential characters, namely, in those points which in the particular family concerned have come through accumulated experience to be considered of generic value, the species are considered congeneric with the type and receive the same generic name. The other mode of treating a genus is to endeavor not so much to group the species about some historic type as to indicate the precise circumscription of the genus by pointing out as clearly as possible just how its species as a whole differ from those of related genera. A species has sometimes been not unaptly referred to as an island in a sea of death. Carrying out this simile as I believe Mr. Cook has done, we may for purposes of illustration consider a genus as a sort of archipelago of such islands, the members of the group being separated by rather shallow channels, while the archipelago is itself separated from other similar groups of islands by deeper channels. It has been urged that a type-species, when accurately defined, furnishes a part of latitude and longitude of one island in the archipelago and thus gives one of the best means of locating the group as a whole. To a certain point this is undoubtedly true, yet the information, however important, is by no means sufficient for purposes of classification, for it is obvious that to know the precise position of an island in an archipelago gives no clue to the shape and extent of the group. To acquire this latter knowledge we must measure and sound

the intervening channels. Let us carry out our figure a little further and agree that the breadth of a channel indicates the extent of actual difference between the plants in question, while the depth of the channel indicates the fixity of this difference. It is obvious that islands may be far part and yet be divided only by very shallow water, the space between them being from its inconsiderable depth very likely to be more or less filled with spits, shoals or sand bars. Similarly, as we all know, two species may in their typical forms be very unlike, yet exhibit such affinity that they are more or less connected by frequent intermediates, hybrids or atavistic forms. On the other hand, two islands may be very near together yet separated by an exceedingly deep channel, in which any intermediate bars, shoals or islets are quite impossible; and in like manner two species may exhibit close habitual similarity and yet maintain their technical distinctions with perfect fidelity.

It is, of course, these deeper channels, these natural intervals, no matter how narrow and difficult to find, that should be diligently sought as yielding the most satisfactory limits of a genus. It is by the relative or complete absence of intergradation that we must recognize differences of high antiquity and profound classificatory significance. It is not by the visible extent of the differences, but by their constancy that their importance is to be measured. This is, of course, no new thesis. It has been reiterated, time and again, in one form or another, by many distinguished biologists. Yet it is a principle habitually disregarded by many systematists, and to its neglect is due a large part of the annoying diversity in current classification. Large genera are daily being divided and new ones artificially created on the basis of differences which are regarded as important solely from their magnitude or conspicuous character and with scarcely a thought as to their constancy. But it is easy to see that botanists who confound differences of degree with those of kind, or lay great stress on the wide divergence of certain type species and fail to take into account the species which are intermediate, are like reckless mariners who estimate the depth of a channel solely by its breadth.

The great majority of new generic propositions rest upon

the examination of a comparatively small number of species; indeed, a considerable part of them are brought out in works relating to some geographically restricted flora. In such cases, it is a practice all too common to treat the newly proposed generic segregates as though they were made up solely of their representatives which chance to inhabit the particular region studied. In many instances this enables the writer to define his genera with a specious definiteness, which may appear very convincing to those whose botanical activities are restricted to the same local flora, but which, when viewed in the light of a broader knowledge of related extra-limital species, is quickly seen to be the merest artificiality.

This introduces a subject which I would earnestly emphasize, namely, that those who attempt to alter generic lines should always take a broad, a cosmopolitan, view of the group concerned. To do so, may, it is true, involve great difficulty. It is a relatively easy matter to divide into groups two or three dozen species of any one of the great genera like *Euphorbia*, *Solanum*, *Cyperus*, *Eupatorium*, *Polygonum* or *Astragalus*. It is a very difficult task to examine all known species of any of these huge genera and show that they may be divided into definable and mutually exclusive groups; but it should be perfectly evident that nothing short of a definite disposition of all the component species of a genus can be construed as a satisfactory and scholarly generic segregation. It would probably be within the bounds of truth to say that wide-reaching divisions of large genera have within the last decade been frequently undertaken without the examination of more than a quarter or in some instances a tenth part of the species involved. Such attempts may be compared, if we return a moment to our marine simile, to the guesswork of a negligent explorer, who, finding an archipelago entered by a deep inlet or bay, should, after sailing a short distance into it, conclude that the channel continued at the same depth and and in the same direction through the rest of the group, and who should, therefore, record such a clear channel on his chart, leaving to future mariners who attempt to sail by his map the unenviable task of discovering by sad experience the

real course and depth of the channel. Neither such a chartographer nor such a botanist is likely to enjoy long a reputation for accuracy or scholarship.

On the other hand, it may be urged, with some plausibility, that many large and traditional genera contain very unlike elements and that those writers who clearly perceive this should not be obliged to maintain the heterogeneous aggregate, even though they may not be in a position to go into the great task of examining all its foreign representatives and deciding in which component group each should be placed. It may be argued, further, that to impose such a burden of work as a prerequisite to every more sweeping generic change would be to retard very greatly the progress of classification. These, however, are mere excuses for hasty and superficial work. In fact, just such expressions as "composed of very unlike elements," are exceedingly apt to be based on differences of magnitude rather than those of constancy. Persons examining our indigenous species of *Polygonum* might very naturally suppose the sections Persicaria and Avicularia distinct genera. It requires a knowledge of the Old World species to perceive how untrustworthy are the distinctions by which these subordinate groups are separated. The caryophyllaceous groups *Alsine* of Wahlenberg and *Melandrium* of Röhling are commonly maintained as genera by writers of central Europe, and if only European species are considered these might seem fully worthy of generic rank. It is after a study of Asiatic and American species that the alleged generic distinctions are seen to be weak and inconsistent. It is an easy matter to separate sharply our few species of *Oxalis* into groups on the basis of homogony and heterogony, on the color of the petals, and on the nature of the root-stock. It is a very different task to arrange clearly in these proposed genera the species of Africa, in which yellow petals are sometimes associated with a bulbose base and purple petals with elongated leafy stems, in which heterogony bears no definite relation to color of petals, and in which scaly rootstocks and bulbose base are actually found in the same individual.

The genus *Hexastylis* of Rafinesque has been recently restored and separated from *Asarum* on the ground that the former has a superior ovary, distinct styles, and filaments shorter than the anthers, while in the latter it is said that the ovary is inferior, the styles united, and the filaments are longer than the anthers. This might seem to be an excellent generic division were it not for Asiatic species of *Asarum* in which an inferior ovary is combined with distinct styles and nearly sessile anthers. Examples of this sort might be almost indefinitely multiplied.

In all these cases the generic segregation is weak, ineffective and unscholarly because it rests on incomplete observation. It is, moreover, distressing to see what a strong prejudice there is on the part of many investigators against taking a broader and more cosmopolitan view of plant classification. If genera appear to be good in a particular region, that is regarded as quite justifying their maintenance in floras treating of that part of the world. This tendency toward insularity is to some extent perceptible in the work of different European nations. It is far more noticeable in the growing separation of the taxonomic work of the eastern and western continents. It is obviously the outcome of the narrowing influence of specialization and should be vigorously combated, for it is seriously threatening not only the uniformity and harmony, but the normal progress and dignity, of our subject as a whole. For it is quite evident that were it to be once admitted that generic limits rest not upon species of the world but are to be fixed in each flora merely according to their chance representatives in that flora, it would introduce a chaos into classification as ridiculous as it would be unnatural. Two genera might be justifiable in the limited flora of Connecticut, which would completely merge were the other New England species considered; or two genera might present marked differences in New England, which would intergrade in the middle or southern states. It is obvious that if we are to obtain any measure of uniformity or stability, genera must be founded not on local, but on a cosmopolitan basis.

It has often been suggested that excessive splitting of genera

has been due to personal vanity of authors who enjoy creating the new binomials involved. However this may be, I much doubt whether any such unworthy motive has played great part in the matter, but infer that many authors share the view of Rafinesque that large genera are unwieldly things; that it is a very difficult matter to prepare a good key for such large numbers of species and that classification is rendered simpler and clearer if the genus can be broken up into fragments of convenient size. In regard to this it may be said that the subdivision of the genus into subgenera or sections accomplishes precisely the same end with no confusion of generic nomenclature. Different minds may work in unlike manner when confronted by the difficulties of identifying plants. Personally, I should very much prefer to have the difficulty at one point rather than at two; that is to say, I should rather have generic lines drawn so widely that genera would be pretty definite and readily recognized, in the manner, let us say, of *Cyperus*, *Astragalus* or *Euphorbia* in the broader and long traditional sense. The recognition of such genera requires little or no mental effort on the part of a botanist of any training. The attention is left free for the specific identification, and this may be undertaken with a happy confidence that all the species likely to come into question will be found in the same group and under the same generic name. These species may be inconveniently numerous, but at least one is not disturbed by any lurking doubt whether, after all, he has got the right genus. I can see no real simplification in having *Mariscus* and sundry other vaguely marked sections of *Cyperus* treated as separate genera, so that in identification one must first struggle with the generic key and then, haunted by some misgivings as to his success in this matter, proceed to the specific key. As I have said, minds may act quite differently in this regard, but clarity of classification is after all a very artificial consideration and it is dearly bought if secured at the expense of misleading statements. Therefore I can not believe that a writer, when dealing with a limited flora, is justified in stating that two genera are distinct if he is wilfully or carelessly neglecting their more or less complete intergradation in some other flora.

It may be thought that the sort of world-wide perspective which is here advocated is a thing well nigh impossible; that a writer who attempts a flora, for instance, of the United States, will have his hands quite full with the difficulties of his already herculean task, and that his progress would be slow indeed were he forced to estimate each generic difference by the large standards of the world's flora. Here I must use a much-dreaded word, quite a bug-bear of many a self-reliant scientist, namely, *authority*. It is indeed quite impossible for any one of us to repeat the accumulated work of many decades which has led to the recognition of hundreds and thousands of genera. We must accept at least a large part of them on authority. The absolute necessity of this is so self-evident that it needs no justification. I am not advocating any slavish submission to the opinion of others, nor minimizing the importance of verifying and in every possible way correcting previous work, but merely urging a wholesome respect for the opinion of those whose intensive monographic work or broad cosmopolitan outlook has given them an exceptional opportunity to see just where generic limits may be most naturally and profitably drawn.

Fortunately, the genera of flowering plants have been comprehensively treated in two or three works of high excellence. These sources of information are sufficiently complete and recent to be of the greatest service to writers on restricted floras. In addition to such general guides there exist for many families very detailed monographs embodying the expert opinions which are the result of long and critical study of all members of the particular affinity concerned. It is not to be denied that such monumental works exhibit a considerable measure of diversity in the interpretation of genera, but this is not wholly a misfortune since it permits a certain elasticity in classification and enables a certain selection according to varying judgments. Furthermore, however great the divergence may be in these large monographic and cosmopolitan works, it is relative uniformity compared with the state which would soon obtain were genera to be defined in each flora solely according to its local representatives.

One of the most unhappy tendencies observable in moder classification is a gradual letting down of standards, a feeling tha if a few ill-defined genera are to be found in a particular famil the others should in the interests of a sort of specious symmetr be cut up until all are about of the same degree of vaguenes and uncertainty. When an author who tends to excess i dividing genera feels called upon to assign a ground for hi action, it is in nearly all cases that the segregates he is makin are quite as good genera as many which already exist.

This process of taking the poorest existing work of other for a guide or as a sample of what is permissible might obvi ously be carried on forever. In the great majority of case this type of classification is the work of authors who have quit lost sight of the fact that it is not the magnitude but the con stancy of the differences which is of real significance in classifica tion. There is, for instance, no more dangerous theory tha that because a particular trait, let us say the presence of corona, forms an excellent generic distinction in one famil it must necessarily be of generic significance in another.

The frequent occurrence in botanical literature of such ex pressions as "a generic difference," "distinctions of generi rank," etc., seems to indicate a more or less wide-spread feel ing that differences of a particular kind or magnitude, o relating to special plant-structures, are in some way recog nizable as diagnostic characteristics of generic value as oppose to those which can be used merely for the separation of specie or varieties. There is a common idea, for instance, that difference of floral structure, or especially one of fruit or seed is almost infallibly trustworthy in the separation of genera This belief has certainly the justification that distinctions in th essential parts of the flower or in the fruit are much more ap to be fixed, are at least far more constant, than those of habit foliage or pubescence, since the latter appear much more sub ject to modification with varying environment. Nevertheles this theory, as a rule of classification, may easily be carried to far. When carefully examined, very few differences in th structure of flower or fruit will be found to be invariabl of generic value. Nearly all appear at some point in th

plant system to be in a fluctuating state. For example, the position of the cotyledons, although possessing a high value in separating many cruciferous genera, completely breaks down in the genus *Lepidium*, where in plants of the closest habitual similarity accumbent and incumbent cotyledons are found. In the Rosaceæ the unlike adnation and connation of the floral parts furnish in some portions of the great family excellent generic and even tribal distinctions. In other rosaceous genera, however, the same diversity of adnation and connation occurs in species which are obviously of such close relationship and so connected by intermediates that their generic separation is by no means convincing. Many other instances of this kind might be cited to show that a difference having great classificatory significance in one place may be almost valueless in another.

It is fair to inquire how we know this. If, for example, genera of the Cruciferæ can be readily separated by the position of the cotyledons, why is it not after all the most logical course to treat *Lepidium virginicum*, with its accumbent cotyledons, as constituting a genus distinct from the other species of *Lepidium* in which the cotyledons are incumbent? There are two pretty obvious reasons against this. One is that in *Lepidium* there are other species which have transitional cotyledons, exhibiting various degrees of obliquity. In the second place, the accumbent cotyledons of *Lepidium virginicum*, although a striking character, are unaccompanied by any other difference of moment. From this fact we may reasonably infer that in this particular group the difference in the position of the cotyledons is of relatively recent origin, for it has not had time to become correlated with any other trait of significance or constancy. This brings us to a matter of great practical as well as theoretical importance in classification, namely, that few, if any, genera carry conviction as natural groups, or, to be more precise, naturally delimitable groups, unless they can be separated by more than one feature. The ideal genus is certainly one in which several distinguishing traits are constantly associated. When limits are properly drawn it is certainly true that a very large number of such ideal genera exist. Unfortunately for

the peace of mind of the systematist, however, there are considerable series of species in certain families, which quite defy classification into genera of this sort. They are groups in which we are forced into accepting a far less satisfactory type of generic division, and in some cases it is necessary to make the most of a single character. Of this fact, the genera *Arenaria* and *Stellaria* furnish an excellent example. So far as I am aware, there is no technical distinction between these genera except in the petals, which are entire in *Arenaria* and bifid in *Stellaria*, and this difference becomes very weak in certain species in which the petals are merely emarginate, yet I doubt if any systematist at present wishes to unite these two large and traditionally maintained genera.

It is thus clear that by common consent we are willing to preserve for the sake of practical convenience certain familiar genera, even though precise technical grounds are lacking and a few intermediates occur. In other words, there is an historic element which will obtrude itself into our classification. Its influence is obviously opposed to a truly natural and symmetrical system; nevertheless, much as it may be deplored on theoretical grounds, it is an undeniable fact, and as such demands careful scrutiny and consideration.

Perhaps no large family shows the importance of the historic element in generic classification better than the Compositæ. The lack of sharp boundaries between such genera as *Aster*, *Erigeron* and *Conyza*, *Solidago*, *Aplopappus* and *Bigelovia*, is patent to all whose botanical experience extends beyond the limits of some local flora, yet so far as I am aware no botanist has been willing to accept a recent proposition to merge several of these genera into one. The genera have through long recognition become a practical aid in classification. They are groups into which at least a very high percentage of the component species may be naturally associated, those of intermediate character being, notwithstanding their undeniable existence, relatively little in evidence.

But it may be asked whether the recognition of such somewhat ill-defined genera is not quite at variance with our fine theories that genera should be groups capable of clear and

mutually exclusive definition, archipelagoes separated by deep and safely navigable channels. Certainly this is quite true, but I must beg you to notice that I am in no wise urging anyone to recognize weak or poorly limited genera; I am merely stating the undeniable fact that certain groups of this sort are now so widely recognized as genera that we have no choice in the matter. *Aster*, *Erigeron*, *Conyza* and the like have become established facts in classification. They fail to reach our ideals, but this does not of necessity mean that we must let down our standards elsewhere. Attention may be called to the fact that when they were first proposed these genera were, so far as they were then known, quite as distinct as could be desired; their present vague and merging state being due chiefly to intermediates discovered long after the founding of the genera. With the increase of knowledge these genera, which once seemed distinct, have grown together; the process has been a gradual one and at no time has it seemed desirable to abandon the idea of these genera, although it has become increasingly evident that it is to a great extent artificial. This is one way in which the historic element has entered into our classification. We may readily admit that the authors establishing these old and now merging genera were in most instances justified in doing so, because, according to the knowledge of their time the groups seemed pretty sharply separable, yet that does not mean that we should take those merging genera as a model for our own work. It is, for instance, a very different matter at this time to pronounce the great and long united genus *Astragalus* a complex of distinct genera, for with our present knowledge of the gradual transitions between these alleged segregates of *Astragalus*, their treatment as separate genera involves a sort of suppression of facts.

It is for this reason that writers who divide large genera on the ground that the component parts are just as good genera as many which are traditionally maintained, are doomed to the disappointment of seeing their propositions neglected. We may readily pardon the older writer who in his limited knowledge of species made some incorrect inferences as to generic lines; who pointed out the probable channels about his archi-

pelago on the basis of a conscientious but necessarily restricted exploration, made, let us say, with a still ineffective sounding apparatus. It may even, for purposes of geographic orientation, be worth while to let his hypothetical channels remain on our charts, their shallowness and danger being duly indicated. It is quite another matter when we are directed by modern writers to record such channels on the chart at places where we know that they do not in reality exist. But it may be asked why, if it is sometimes desirable to leave the record of an old error, may not the very similar new proposals be equally useful for purposes of geographic orientation? If it is worth while to let old and now merging genera stand, why not make new ones of the same kind? But this end can be accomplished equally well by the use of subgenera or sections, and that, too, without our seeming to indicate that differences are more constant than they really are, without our being obliged to record a navigable channel where none exists.

The division of large genera into several smaller ones is commonly accompanied by a certain loss about which little has been said, the obscuring, namely, of the existence of the larger affinity which had been indicated by the old and more comprehensive genus. However diverse the elements of *Œnothera* may be, it can not be doubted that they form a recognizable whole, of which the constituent species are more nearly related to one another than they are to *Epilobiums*, *Gauras* or to species of other onagracious genera. In other words, *Œnothera* in its comprehensive sense is a natural, although perhaps rather loose group. If we show the narrower affinities, by the use of subgenera, we still have the word *Œnothera* left to cover the larger relationship. This is a matter of importance, for it gives the student at once the information that the affinities of the parts of the genus are closer than those of the genus to other genera. If we give up the old genus *Œnothera* and substitute a group of small component genera, we lose sight of the larger affinity and our classification is accordingly less clear and rich in its statement. It has suffered a distinct loss in the abandonment of the genus *Œnothera* in the larger sense. An added disadvantage is that we are making the constituent groups, although

they are of a nearer affinity and clearly belong to a subordinate rank in classification, appear as if they were coordinate with other genera which are still treated in the larger way. It is clear, therefore, that the division of a loose but more or less natural genus is attended by some disadvantages quite unconnected with any considerations of sentiment or temporary inconvenience.

We have seen that the difficulties of classifying plants in a really natural and logical way are somewhat increased by the involuntary and well nigh necessary admission of a certain historic element into our systems. There is another source of this artificiality, besides the temptation to allow poor genera to stand, on the ground of long usage. The relation of a genus to its name is a matter which exerts no small influence in this regard. The attempt to determine which of several names is to be retained for a given genus constantly forces us to consider the historic basis on which the genus rests, and to attach its name to some species or group of species to which it was first applied, to determine, in other words, what was the type of the genus, and to maintain the genus in such a way that it may always be true to its type. While sympathizing to a considerable extent with those botanists who desire to place our nomenclature upon a more secure basis by attaching the names to recognized types, I feel that the methods employed will have to be very cautiously applied or they will tend greatly to increase the artificial element in our system. The historic type is not a natural thing; it is merely that particular form of plant life which was, often quite by accident, first discovered and, therefore, first received the name which it bears. Later discoveries often show that this first species of a genus is by no means of a typical, or, as one may say, central character. It is often quite peripheral, perhaps even an aberrant or outlying member of the group to which it belongs. However important the historic type may be in nomenclature, it is obvious that it is of no particular significance in classification, and any employment of the type method in the determination of proper names must not on any account be permitted to exercise any influence in classification. The word type itself is decidedly unfortunate

as thus applied to what is often very far from being typical. In this as in some other phases of taxonomy it is of the greatest importance to keep it clearly in mind that nomenclature, although very necessary to classification, is a thing wholly apart from the classification itself. It is, furthermore, quite evident that nomenclature should be subservient to classification and that the clearness and accuracy of classification should never be sacrificed in order to give beauty or symmetry to any system of nomenclature.

I have now stated my premises and perhaps you are looking for some conclusions, or possibly some practical suggestions as to the best way of obtaining a greater harmony in the matter of generic classification. The difficulties of the problem are quite apparent. The limitation of genera has always in the past rested on individual judgment and it must continue to do so in the future. There is no way of making all people think alike on a subject so intricate, and I am by no means certain that complete unity is really needful or desirable. The fact remains, however, that although the genera of the flowering plants have now been scientifically studied for about two centuries, there is at present, in America, at least, a degree of diversity in their interpretation which is rather discouraging. It is disheartening because it is impossible to see in it any real progress toward a well-rounded and satisfying system which will win the confidence of the professional botanist, give uniform training to the student and command the respect of our colleagues in other branches of science. From this, I think that it is perfectly clear that botanical systematists have certain imperative duties in regard to this subject. These duties are, in the first place, great caution in making changes; and in the second place, a feeling of obligation, when these changes seem necessary, to state the reasons for them so clearly and forcibly that they will appeal to all thoughtful and discriminating workers in the same field. The burden of proof should always rest upon the writer suggesting the change. It is rather surprising to notice how lightly this matter is taken by some, who attempt sweeping changes. It is by no means rare to see a few habitually similar species of a large genus split off and set

up as a new genus with scarcely any attempt to give accurate definition to the new group or tell just what traits are of diagnostic value in separating it. The authors of such work indolently and carelessly shift the burden of proof upon others. Their statements regarding genera are scarcely more than hypotheses, but unhappily they are expressed not as theories or mere conjectures, but as facts. This, however, is not the worst type of publication on this subject, for it is even more misleading to assign generic characters as in the case of the segregates of *Oxalis*, for instance, which do not hold good. Do not understand me to say that authors have been intentionally misleading, for I do not believe that to be the case. I merely mean to say that some writers who have made rather free changes in generic classification have taken so lightly their responsibilities in doing so and have felt so little the obligation to present any complete or scholarly proof of their dogmatically stated conclusions, that they have been tempted into rash and hurried assertions, which are in many cases decidedly misleading.

It may perhaps be thought by some that this is unduly hard on writers who have intentionally adopted a lower grade of generic classification than the somewhat ideal one described a few moments ago, who believe in the practicality of treating as genera minor groups of allied species, although it is by no means maintained that these are sharply defined or non-intergrading. To this it may be said that these minor groups, being of a different classificatory rank from the larger long-established genera, such as *Cyperus*, *Œnothera*, *Astragalus*, *Ranunculus* and the like, should not in any natural or well-devised system be treated as coordinate with them and bear the name genus, this name having been applied to groups of a superior rank. This seems to me a very important matter. For if it were considered proper to apply the term genus to smaller and smaller groups with more and more vague definition, there is surely no end in sight and no real progress toward a definite and reliable system. To draw an illustration from another science, it may be noted that each generation sees an added perfection and accuracy in apparatus for physical measurements of space, time and gravity, but the physicist does not feel it necessary on this account

to shorten the meter scale, make his clock run faster, or file down the weights of his balance. His old constants remain as treasured acquisitions and it is by careful reference to them that his progress is made.

What we need in botanical classification is a series of such constants, a number of graded categories which can be generally endorsed and properly respected. Standards as definite as those of the physicist are, of course, quite unattainable in dealing with the variable and often intergrading groups of organic creation. But where absolute accuracy and uniformity are impossible, we should the more diligently seek to preserve such standards as exist. As has been pointed out there are but few families of flowering plants which have not been comprehensively treated by monographers who, so far as their particular group was concerned, have been in a position to see pretty clearly where it was best to draw generic lines. While it must be admitted that there are many minor differences in the generic concepts exhibited in the scholarly and monumental work to which I here refer, yet they establish a good usage, which on the whole has a considerable measure of uniformity and which goes far to establish the rank of such categories as genus, species and variety. This fact is clearly shown by the contrasting work of those free-lances who, armed with the less effective weapons of a more restricted knowledge, have, in doing independent battle upon the difficulties of generic classification, followed other tactics and set up new standards. I doubt if they have realized how quickly and fully the personal equation is recognized in regard to their work, or how generally even the amateur and layman grasp the fact that their generic and specific propositions are not up to the standard. No one can change the temperature by making the degrees of his thermometer smaller. Least of all is it possible to make people believe that the shortened degree is as important as the longer one. Time spent in this mere letting down of standards and shifting of ranks is worse than wasted. The process is annoying and confusing, for to the natural difficulties of generic classification plus a certain inevitable historic element

of artificiality, it superimposes the most awkward and irritating difficulty of all, namely, the personal equation.

Let us get something done and not spend our time in endless and profitless strife about first principles, thereby bringing confusion into what may be regarded as fairly well established already. There are limitless fields for further profitable work in the finer classification of the flowering plants without perpetual tampering with the boundaries of important and long-studied genera—a type of activity very prone to sink to the level of a mere juggling with names. Having said so much against generic changes of a superficial character, I fear some of my hearers may get the impression that I am opposed to generic changes in general and perhaps even to the further investigation of generic limits; but this in no wise the case. There is certainly great opportunity for further and very profitable study of generic classification. The genera of several families, as for instance the Cruciferæ, are in many cases pretty artificial groups. We need much further knowledge of the relationships of the species concerned. Let those who wish to be of real service in this matter give us what we so much desire, namely, additional light upon the ontogeny, embryology or finer anatomy of these species, sources of information sure to yield data of high classificatory importance.

In closing let me urge that, while we remit no effort to secure further light on this subject, there should be a general agreement to treat the accepted and traditional interpretation of large and important genera as sacred and binding until we can furnish definite and convincing evidence that change is needful, and that for the welfare and dignity of our science, all should unite in opposing changes of the artificial sort, which consist merely in the shifting of ranks and modification of standards.

REPORT OF THE SECRETARY OF SECTION G.

Section G of the American Association for the Advancement of Science met at New Orleans during convocation week. In the absence of the chairman, Erwin F. Smith, the meetings of the section were presided over by B. L. Robinson, past-chairman and vice president of the association.

The following papers were presented:

The Secretion of Salt by the Leaves of Spartina Stricta: F. H. BILLINGS.

The leaves of *Spartina stricta* are longitudinally grooved on the ventral surface. In the grooves are found projections from the epidermis. The projections are hollow and are closed at the end by a thin wall. They are seen to be tipped with drops of liquid which upon evaporation leaves a deposit of salt. Just how the solution of salts is secreted has not been determined, but it is conjectured that the removal of such salts would be a benefit to any plant, such as *Spartina stricta*, which lives in brackish or salt water marshes.

Improvement of the Quality of Grapes: T. V. MUNSON.

There are three chief ways of improving quality in any class of fruits, namely; (1) by cultivation, (2) by selection of kinds, (3) by combination of kinds. By the practice of any one of these considerable improvement can be made, but much more by either selection or combination of varities than by cultivation, and when all three are used conjointly the greatest improvement is obtained.

Improvement consists in increasing the size of the cluster and berry and the sugar and agreeableness of flavor, in market and table varieties, and by getting a greater per cent of sugar in the juice with nearer approach to the ideal ratio of acid and sugar for light wines of 6 per mill acid to 80 degrees sugar by Oechele's scale and characteristic "bouquet" or flavor that is agreeable to wine judges.

The Munson canopy trough trellis and system of pruning and training on same, have been devised and tested in comparison with other leading methods for some twenty years by the writer and by various other persons, proving it to be superior.

Hybridization sometimes produces entirely new flavors that the poor species do not possess. Taste is an unreliable guide in the production of sweeter or more acid kinds because a variety actually low in sugar may be pronounced sweet simply because it is disproportionately low in acid content.

The writer selects varieties systematically for hybridizing purposes, using the sacharometer and acidometer to test the juice.

The Preparation of Non-toxic Distilled Water: B. E. LIVINGSTON.

Experiments upon the distilled water of the laboratories of the Bureau of soils of the U. S. Department of Agriculture showed it to contain two classes of materials deleterious to plant growth, the non-volatile and the volatile. Redistilling in glass benefited the water to a great extent but did not remove all of the injurious substances. Those remaining must be considered as belonging to the volatile class, being able to pass over from the retort with the water vapor. It was found that apparently all of the deleterious bodies originally present in the distilled water were removed by shaking the latter with finely divided solids, such as thoroughly washed ferric and alumimium hydrate and carbon black, and then merely filtering out the solid. As good water for experiments in plant physiology can be obtained by this method as by any method of redistillation. The explanation seems to lie in the great absorptive (or adsorptive) power of finely divided solids.

Ascidia in Fraxinus: GEORGE H. SHULL.

Specimens, photographs and drawings were exhibited to show the occurrence of ascidia in *Fraxinus Americanus*, and this occurrence was construed as a strong support for the thesis that variations of plants and animals are narrowly limited in kind by the characters they already possess. Although this abnormality must be extremely rare in *Fraxinus*, and has never been recorded, there is a group of young trees near the station for experimental evolution on which it is a frequent occurrence. Of thirty trees taken consecutively, eleven bore 103 acidia, the other trees being entirely normal. The relation of these abnormal leaves to the normal pitchers of *Sarracenia* and *Nepenthes*, and to the peltate leaves of many other species, was recalled, and it was shown that the relation between the pitcher and the peltate leaf rests upon the ratio between radial and tangential growth of the leaf tissue, and that this ratio fluctuates about a a definite mean value for a particular position in any given species, whether the development occurs in a complete circle or in a broken circle. This ratio determines the narrowness of the ascidium, as well as many other details of leaf form, such as plications, curled and upturned edges, etc. It was observed that this ratio was apparently greater in the ascidia than in a normal leaf, and it was suggested that this appearance is due to the development of a sector of leaf tissue in the place of the normal sinus, and that this sector must be taken into account when comparing the ascidium with the normal leaf. Exception was taken to the frequently expressed idea of fusion, the essential feature of the ascidium being described as due to the retention of a capacity for further radial development by certain cells in the median dorsal line, which cells normally lose this capacity at a very early stage of development. It was noted that the ascidia could be referred to two types, the more common form involving the basal margin of the leaf, the other being located within the leaf

and leaving the basal margin normal. The former was called a seamless ascidium. It comprised a little over 50 per cent. of the cases, and the seamed ascidia were found in about 47 per cent. Several peculiar combinations of the two types were noted. The stalk of the seamless ascidium differs from a normal petiolule in that it is cylindrical and contains a single concentric bundle, the normal stalk containing, in addition to this, two small collateral bundles running beneath two ridges which are continuous with the leaf margins. A strongly marked periodicity in the position of the ascidia in the leaf was found to agree closely with that found by Miss Tammes for their occurrence on the branches of Tilia, which fact suggests the morphological similarity of leaf and branch. This period for *Fraxinus* was as follows: Of 103 ascidia 96 were on terminal leaflets, five on the ultimate pair of lateral leaflets and two on the penultimate pair. This occurrence of ascidia on the terminal leaflets agrees with recorded observations on other species having polyphyll leaves and this fact was adduced as further evidence of orthogenesis. When the two leaves at any node spread laterally, they show a strong tendency to be symmetrical with regard to the occurrence of ascidia, but when they spread in a vertical plane, only the lower leaf bears an ascidium. The extreme localization of ascidia-bearing ash trees was presented as evidence of their recent origin at this particular spot, and the fact that a large number of individuals of various ages possess this structure was held to be strong evidence in favor of their inheritability, but both the origin and inheritance must await demonstration by pedigree-culture.

Phytogeography of Florida: P. H. ROLFS.

(I). A discussion of the general conformation of Peninsular Florida giving a general outline of the topographic regions.

(II). The distribution of pine woods. Plants associated with this formation.

(III). The scrub formation and its plant association.

(IV). The mangrove formation and its associates.

The Florida Strand: P. H. ROLFS.

A discussion of the Florida strand showing the principal plants with effect of location on various species.

The Everglades: P. H. ROLFS.

A general description of the everglades giving the plant societies and conformation of the surface.

The Development of Armillaria mellea; The Development of Agaricus campestri: GEO. F. ATKINSON.

These papers described the development of the sporocarps from the homogeneous condition up to the differentiation of the parts of the mature structure.

The Behavior of the Pollen Tube in Houstonia cærulea: CHESTER A. M MATHEWSON.

The ovules of this plant are without integument and there is therefore no micropyle. The course of the pollen tube is analogous to that described by Lloyd for other Rubiaceæ. It follows the style as far as the basal element of the ovary partition. Here it enters the tissue of the placenta stalk, and following this it enters the placenta. It reaches the ovule through the funicle and is then directed to the egg end of the embryo sac. (Will appear in *Bull. Torr. Club*).

Ring Formation in Artificial Cultures: GEORGE C. HEDGECOCK.

Further studies have been made of the formation of fruiting rings in artificial cultures on agar media of *Cephalothecium* and *Penicillium*, and the same character noted in cultures of other fungi. Cultures were grown in the dark, and in ordinary light, establishing that the type of formation studied occurs only under the influence of light. Next, cultures were grown under rays of light transmitted through solutions of orange, red, blue and green in addition to the previous conditions. Under the effect of blue rays and in the dark no rings were formed, while rings were formed under the other conditions. The rings formed consist of alternating daily masses of denser spore formation. Daily fruit rings were observed with cultures of *Mucor* and *Homodendron*, in addition to those already reported. These rings must not be confused with those of the type described by Milburn on certain kinds of media with *Hypocrea rufa*, since the latter were not formed daily, each occurring during a much longer period.

Notes on the Morphology and Embryology of the Nymphæaceæ: MEL. T. COOK.

As a result of the recent work of Conard and others the writer has again taken up the study of this family, using Cuban material for the work. Members of the genus *Nymphæa* correspond with the writer's previous work upon this group. Members of the genus *Castalia* show some differences in that the embryo sac is not so long and the embryo has a suspensor. Members of the genera *Bracenia* and *Cabomba* correspond with *Nymphæa* in the enlargement of the embryo sac. All embryos show monocotyl characters, but some show characters similar to those of dicotyls. The Cuban species of *Castalia* show more striking dicotyl characters than our northern species.

North American Species of Peridermium: J. C. ARTHUR and F. D. KERN.

This paper dealt with certain fungi growing on the leaves of various coniferous trees, and sometimes on the limbs. A half dozen kinds form large swellings on the branches and trunks of pines and do much injury, not only decreasing their value for lumber, but ruining small trees in nurseries. Altogether twenty-six species are described, a number of them being new.

Stomatal Action and Transpiration in Fouquieria splendens and Verbena ciliata: F. E. LLOYD.

The evidence derived from the comparative study of these two types leads to the conclusion that there is no close correlation between transpiration and stomatal action. The maximum opening of stomata is reached some hours earlier than the maximum of transpiration, and, further, wide variations in the rate of transpiration may take place without any change in the size of stomatal openings. No evidence is found for the "temporary opening" of Fr. Darwin.

Absorption of Atmospheric Moisture by Desert Shrubs: V. M. SPALDING.

The prolonged period during which *Fouquieria splendens* and some other desert shrubs remained in full leaf in the summer and fall of 1905 suggested the probable connection of this fact with the unusually high relative humidity which prevailed during that period.

Experiments were carried out with twelve different species of perennials to ascertain whether they are capable of absorbing water vapor directly from the atmosphere. Leaves and other parts were accurately weighed before and after exposure to a saturated atmosphere.

The leaves of *Fouquieria* do not absorb water from the atmosphere, but the buds and branches are capable of such absorption. In the case of *Celtis pallida* and a number of other species there is no satisfactory evidence of the absorption of water vapor from the atmosphere by the living parts of the plant before pathological changes set in. Experiments with *Covillea tridentata* indicate a positive, though limited capacity for leaf absorption. Other plants vary in their deportment in this respect.

There is no evidence that the extremely small amounts of water absorbed in this way are utilized in the body of the plant, but there is every reason to conclude that high relative humidity proves to be a decided advantage to various desert plants in time of drouth by preventing excessive transpiration of the leaves and thus prolonging the period of their physiological activity.

Correlation between Ovules and Matured Seeds in Leguminous Fruits: J. A. HARRIS.

The paper is a study of the variability of ovules and matured seeds in the fruits of *Cercis*, *Cassia*, *Wisteria* and a garden bean. The series of constants is as yet too small to permit of any comparisons of the coefficients of regression of matured seeds on ovules with those found in inheritance, but the material promises some interesting results along this line. The regression would seem to be an obstacle to the fixing of the extremes of fluctuating variability by natural selection.

The Structure and Cytological Changes accompanying Secretion in Nectar Glands of Vicia faba: CHARLES R. STOCKARD. (Will appear in *Bull. Torr. Club*).

The author finds that the nectar glands on the stipules of *Vicia faba* contain layers of cells whose contents have different chemical reactions, which fact is indicated in living material by their differences in color. This probably points to a difference in metabolic activity in the cells, since those of definite layers have similar reactions. The color response of the cells to acids and bases is the typical litmus change; acids causing the cell contents to become red, bases changing it to blue.

The nuclei are granular in structure, often coarsely vacuolated with one or more plasmosomes surrounded by vacuoles. Their shape tends toward spherical, but in old glands they become shrunken and slightly irregular in form. The position of the nucleus in the secreting cell varies greatly, but it is more often near the cell center. It is never observed to give out granular material directly to the cytoplasm, though evidence is strongly in favor of the fact that it does transmit a substance to the cytoplasm which finally forms, or causes to form, granules that take in the older glands the nuclear stains. In rare cases the nucleus loses its chromatin in old glands and colors with plasma stains, staining with the acid fuschine of Auerback.

The cytoplasm undergoes changes in structure as secretion progresses, first becoming vacuolar, then slightly granular, still taking plasma stains, and finally densely granular staining with the nuclear dyes. There is evidence to indicate that the cytoplasmic changes are controlled by the nucleus.

The nucleus seems to be the center of metabolic activities participating in the formation of the secretion substance, but playing a passive rôle in the actual process of secretion or extrusion of material from the cell.

The following are the titles of papers presented at a joint meeting of the section and the American Mycological Society:

Some Reasons for Desiring a better Classification of the Uredinales: J. C. ARTHUR.

Uredineæ of the Gulf States: S. M. TRACY.

North American Gill Fungi: F. S. EARLE.

Lichens and Recent Conceptions of Species: BRUCE FINK. (By title.)

Cultures of Colletotrichum and Glœosporium: P. H. ROLFS.

The Affinities of the Fungus of Lolium temulentum: E. M. FREEMAN.

Peridermium cerebrum Peck and Cronartium Quercum (Berkeley): C. L. SHEAR.

Ramularia; An Illustration of the Present Practice in Mycological Nomenclature: C. L. SHEAR.

Notes on Pachyma cocos: P. H. ROLFS.

Penicillium glaucum on Pineapple Fruits: P. H. ROLFS.

The Occurrence of Fusoma parasiticum Tubeuf in this Country: PERLEY SPALDING.

Some Peculiar Fungi New to America: W. G. FARLOW.

FRANCIS E. LLOYD,
Secretary.

SECTION H.

ANTHROPOLOGY.

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ADDRESS

BY

WALTER HOUGH,

VICE-PRESIDENT AND CHAIRMAN OF SECTION H FOR 1905.

PUEBLO ENVIRONMENT.

The great city of New Orleans lies near the threshold of a portion of the continent to which the term mysterious is often applied. With good reason the southwest receives the appellation; for its treasures of natural scenery lavished with inconceivable largess, the picturesque aboriginal population who retain in great part the customs of immemorial centuries, and the silent mounds which are what remains of the homes of the ancient people, all speak of the Old New World cradled and fostered in the bosom of the inaccessible mountains, till it became a representation of the man's progress toward civilization.

The southern portion of the Rocky Mountain Highland has two chief geographic features, the one a depression called the Great Interior Basin and the other the Pueblo plateau. The latter may be subdivided into the Rio Grande valley, the Colrado plateau, and the Gila Slope, lying in the four political divisions named Colorado, Utah, Arizona, and New Mexico.

This plateau, which contains the bulk of the elevation on the western half of the United States, is mainly embraced in the triangle lying between the eastern side of the Rocky mountains and the Rio Colorado, the western side bounded by Great Basin. Its slope is from north to south in the eastern portion where the Rio Grande drains the trough lying just east of the continental uplift, but the main slope is toward the southwest and is drained by the Colorado and its

affluents. The plateau lies from four to ten thousand feet above sea level, but there are great contrasts in elevation from 14,000 feet above to 300 below the datum. In this region the north and south ranges of the Rockies break up and form a complex of mountains running east and west, plateaus, plains, basins, buttes, broad valleys and narrow canyons giving great diversity of the most remarkable natural features to be found in the world.

The geology is that of later rocks, principally the easily eroded Cretaceous and other mesozoic formations. Tremendous volcanic activity in former times has poured out vast floods of lava which together with tuff form the most noticeable physiographic features of the region.

Latitude, elevation, and natural barriers here conspire to produce modifications in climate. This is seen in the convolutions of the isotherms of 50°, 59° and 68° crossing the region, the scanty rainfall occurring in the winter and summer months, the excessive insolation, the extremes of day and night temperature, the high winds and rarefied air, which characterize the arid environments.

The fitness of the southwest to sustain biotic forms depends mainly upon rainfall, which itself is regulated by cosmic and geographic conditions. Thus the uprush of heated air from the sun-baked plateaus during the summer draws in moisture-laden air from the oceans, producing rains which are unequally distributed; the higher mountains acting as condensing centers receive the most, while the plains are scantily watered. The receptivity of the land must also be considered, the mountains covered with vegetation storing water and the bare land shedding it into the rivers which must carry at times vast floods and during long periods remain perfectly dry. Everywhere is evidence of the colossal agencies which are at work reducing the land to sea-level. This workshop is littered with the bones of the mountains, and the dust that is sorted by water and wind moves freely to lower levels or is blown higher to again resume its gravitational course.

Despite the generally adverse conditions set forth, there flourishes here a flora of a peculiar character which forms

the basis of subsistence for an extensive fauna, and also the new-comer man who has pinned much of his faith to natures supply. The region is not in any part a desert in the true sense of the term, which is applied to lands deserted because of an inhibition of life; but it is rather a semi-arid environment, in which a preponderance of desiccative and other factors have restricted and minimized life. These restrictions are observed in full force among the plants fixed in the earth, and therefore played upon by all the natural forces to which they must adapt themselves by slower changes than are required by higher biotic forms. The characteristic climatic flora is thus xerophytic, or dry-leaved, where the leaves are small with devices for preventing too rapid evaporation, stems contain clorophyl and act when leaves fall away, etc.; these are adaptations which give some plants the freedom of the desert. Other plants are succulent and spring to quick fruition when rains occur; other plants have perfected water-storing devices in stem, root, and branches, as the cacti, yucca, atriplex, sarcobatus, etc., and still others can live in soils containing an excess of mineral salts.

Most of the desert plants bear witness to the struggle with sun, wind, rarefied air, and inhospitable soil; thus they present a gnarled, wrinkled, and bizarre appearance, often similating trees dwarfed by the gardeners' art. Unlimited opportunity is here for isolation by natural boundaries, which, if not a factor in the origin of species, at least powerfully aids in the preservation of species.

Much that is observed as to plant life is true also of animal life, giving a fascies by which Merriam's Austral regions may be characterized.

In all discussions of this environment, little or no attention has been paid to the effects of light, which is here at its maximum. Without entering into detail as to the physiological sequelæ of light from other parts of the spectrum, the rays from the violet end may be considered. These rays affect all life submitted to them in a harmful manner by checking or prohibiting cell growth or metabolism. It will be found that many of the protective features of xerophytic plants and

of animals which are attributed to aridity, rarefied air, soil, etc., are adaptations due to avoidance of dangerous rays of light. This is to be noticed in the habit of some delicate plants which thrive in the shade of hardy plants, the protective covering and nocturnal habits of animals, and the architecture and shelter instincts, as well as skin color of the ancient and modern Indians who lived in caves, cliff shelters, or cavate houses, or whose pueblos as a whole or as to the individual houses were constructed to admit a minimum of light.

But from far different causes, though still environmental, pueblos were generally oriented with reference to the east; first, for the utilitarian purpose of receiving the early morning sun, grateful after the chilly nights of the high regions; and second, on account of the importance of the rising sun in heliolatry.

It is difficult to realize the immense modification of animal and vegetable life which the white man has wrought in this region during the thirty years of his active occupancy. At the beginning of this period the region was well grassed and supplied with other vegetation adequate to the needs of vast herds of antelope, elk and deer; rodent animals and birds were plentiful, and carnivores had abundance of prey. As a result of vegetation a humus had formed on all protected situations, rainfall was absorbed and equalized in distribution and the terrific denudation which gashes the land at present was not begun.

The country was adapted to grazing and especially favorable on account of temperature and latitude, and at once great herds of cattle, horses and sheep were introduced from Texas where the range had failed. The result was that the range became overstocked, the grass disappeared under the tongues and hoofs of myriads of domestic animals, shrubs and trees were browsed and destroyed or swept away by fires, from certain regions species of plants vanished, and the land lay bare to the augmented winds and torrential rains. Trails became profound arroyos and the humus vanished in the streams and the surface of the country was stone, sand and gravel. Not the least of this baneful influence was the drying up of springs and other sources of water, and more than one observer collected data going to prove the progressive desiccation of the Pueblo region.

These facts must be borne in mind in discussion of the environment of the southwest. As an example, it may be stated that in the exploration of one ancient pueblo at Winslow, Arizona, the bones of thirty-seven species of animals were taken from the house refuse; it is not probable at present that a naturalist could collect five of these species from the environment. Wherever the explorer's spade has been put in the ancient ruins, facts of this character come to his notice, even if he has not heard the story from the early settlers or Indian traditionists.

There is no doubt that cycles of dry and wet seasons occur in the southwest, but the periods have not been definitely observed. Inferential data has been secured from exploration in the ancient ruins that render it possible to explain the migrations of early populations.

The conditions of the environment briefly recapitulated are:

1. A plateau of considerable elevation isolated geographically.

2. Slight rainfall, locally distributed; absence of cloud blanket; excessive light, radiation and evaporation; high winds, dust storms; rarified air.

3. Forested mountains, plains with xerophytic, hyhrophytic, and halophytic vegetation; plant colonies; desert animals.

Within this general enclave we have several sub-environments which may be considered from the point of view of the availability for habitation by man.

Sub-Environments:

1. Prohibitive to man and in great degrees to animal and vegetal life.

2. Precarious except to man in low grade of culture, as roving, hunting, and naturistic tribes. Animal and vegetal life sufficient.

3. Habitable by man acquainted with agriculture, but more or less precarious.

4. Favorable for agriculture and production of economic surplus.

The sub-environments more favoring in the struggle for existence are:

1. Mountains at sources of rivers. Here are narrow valleys for agriculture with occasional irrigation; game, nuts, fruits and plants; timber; building material, etc. The temperature cold with short growing season.

2. High plateaus with marshes, lakes, ponds. Land lying well for catchment of water. Temperature as in 1.

3. Mesa country, with broad plains and valleys; springs; streams flushed at seasons.

4. Riverain lands in lower stream valleys suitable for irrigation by canals or warping.

The effect of this environment upon plants is to reduce them to their lowest terms; animals, to modify them in important ways; man, to subject his mind to the stress of severe conditions, reacting noticeably on his body, and mightily on his thought and material progress.

The environment was suitable, or extinction of tribes followed or a movement was made to a new sub-environment. Thus the constant and seemingly erratic migration of tribes which have covered the Pueblo region with remains of ancient towns may have been due to natural causes which disenvironed them, such as earthquakes, failure of springs, etc. The final localization of the pueblos is an index, in large measure, of the reginal fitness.

It is probable that the tribes coming into the Pueblo environment were at first confined to mountain regions where there is a permanent water supply and natural subsistence, and that gradually they spread along the water courses and into all the sub-environments. With the increase of population the building of permanent villages of stone, the beginning or extension of the agriculture of maize—which cereal is a major factor in the distribution and permanency of tribes—the settlement of the Pueblo region went on apace.

It is apparent that in the advanced culture stage of the Pueblos the privations of an environment had less restrictive character than in earlier stages. Gradually they attain superiority to the environment which had worked on them to the extent of its capabilities, and this has been the history of the growth of mankind.

Thus the regions least favored, in fact, prohibitive to tribes who had not the schooling of experience, became the seed fields of advanced tribes. Given unfailing springs as a starting point, the waste sand flats of streams occasionally and temporarily filled with water became cornfields which yielded bountiful returns to the Indian agriculturist. These regions yielded the surplus which is necessary for the building of an advanced civilization, and here rather than in the favorable subenvironments arose the true agriculture of cereals on which basis the civilizations of the world now rest.

The environment determined largely the methods of application of water to land. North of the great ridge which crosses the southern portions of Arizona and New Mexico forming the watershed of the Gila salt river are found the more primitive methods of irrigation, that is by simple canals diverting water from streams to the nearest land. and by warping or spreading a fan of water from a point in the stream where the bank and bed of the stream are at a uniform level by slight temporary barriers. South of the ridge which absorbs the cloud moisture and diverts it into the Gila we find a more complicated system in the trunk and lateral canals of great extent employed by the Indians who inhabited this region. Here the rivers lent themselves to irrigation, and agricultural tribes were led to employ the facilities to their betterment.

The somatology and culture of the Pueblos in ancient times are known to have presented a remarkable uniformity, and here may be found an argument for the compelling, panurgic force of the environment. Time and isolation must be considered as concomitant factors in the formation of a Pueblo type under the peculiar transforming character of the environment, which, while it produced uniformity in many respects, may have

tended to perpetuate the five language stocks which prevail in the region.

The most obvious effects of Pueblo environment are those connected with irrigation, architecture, arts and religion, and in the latter the fullest sway of its causation is shown.

Without doubt the following of these and other lines of inquiry relating to the habits and customs of the Pueblo Indians will be productive of valuable material on this subject, necessarily but sketched in this communication.

REPORT OF THE SECRETARY OF SECTION H.

[No papers were read before Section H at the New Orleans Meeting.]

SECTION I.

Social and Economic Science.

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ADDRESS

OF

MARTIN A. KNAPP,

VICE-PRESIDENT AND CHAIRMAN OF SECTION I FOR 1905

TRANSPORTATION AND COMBINATION.

We are so constituted that each of us looks at the problems of life from a somewhat different standpoint. The opinions we form, the principles we uphold, the policies we advocate, are all influenced more or less by the work in which we engage and the kindred range of our reflections. It is natural, therefore, that I should find the origin of many present-day questions in the facts of modern transportation and communication, and that I should entertain views, perhaps indulge in fancies, which those facts suggest.

The primitive man traveled on foot and moved his scanty belongings by carrying them in his arms or on his back. Even the rude vehicles and water-craft which he eventually learned to construct were propelled by his own muscle, and we can only guess how long it was before he obtained any other motive power for the transfer of his person or his property. In every way his life was meager and isolated, for he had not acquired the art of writing, and intercourse with his fellows was confined to ordinary speech. Outside the family to which he belonged, or the tribe with which he gathered, he had no community of interest, felt no friendship and desired no alliance. His associations were as limited as his means of conveyance.

In a later but still very remote period there came a great increase of motive power by the subjugation of animals, and their employment for transportation on land, and by the use of

sails and rudders which multiplied many times the efficiency of water carriage. When these two results were secured, man had added to his own bodily powers the superior strength of beasts of burden and the enormous energy derived from the winds of heaven. This was an immense advance and marked the beginning of that wonderful civilization which slowly followed. The animal kingdom was brought into service for the various functions of land distribution, and the ship which could be sailed and guided made every waterway subservient to man's requirements. Early in this period also he learned to express his ideas by symbols or written words, and thus was enabled to transmit his thoughts by the same agencies that transported his possessions.

This leads to a fact of history which seems to me not merely significant, but profoundly impressive. With the subjection of animals and the use of wind-propelled vessels, both of which achievements reached a high degree of perfection in the unknown past, the means of transportation, broadly speaking, remained unchanged and unaugmented until almost down to the present time. Long before other agencies of conveyance were dreamed of, while ox and horse, oar and sail, were the only means of transport, the race had occupied most of the habitable globe and reached high levels of national greatness. Strong governments were established, vast populations engaged in varied pursuits, and opulent cities crowded with every luxury. The institutions of society had acquired strength and permanence, the arts of leisure and refinement had approached the limits of perfection, and inductive science had laid firm grasp on the secrets of nature. Great inventions and discoveries had widened the fields of activity, furnished the means and incentive for multiplied vocations, and opened up in every direction alluring vistas of advancement. In a word, there was the developed and splendid civilization of only little more than threescore years ago, before any new or different motive power was utilized for production or distribution.

To my mind it is a matter of fascinating import that the long procession of progress down to the century just ended was conditioned by and dependent upon agencies of transportation which

were themselves essentially unprogressive and incapable of important betterment. True, there were minor modifications from time to time in the line of mechanical adjustment, but the general methods employed, and the results obtained, showed no marked improvement or material alteration from those applied in the earliest days of commerce. Reduced to the forms in ordinary use, there were at the last as at the first the beast of burden on land and the oar and sail on water. Yet thus hampered and restricted in the means of transportation, which is the basis of all development, there was built up in the long process of years the varied and advanced civilization which the last century inherited.

Then all at once, as it were, into and through this social and industrial structure, so highly organized, so complex in character, so vast in its ramifications, yet so adjusted and adapted to the fixed limitations of animal power, was thrust the new mode of conveyance by mechanical force, the sudden wonder of transportation by steam. The advent of this new and marvelous agency was the greatest and most transforming event in the history of mankind. It wrought an immediate and radical change in the elemental need of society, the means of distribution. The primary function was altered both in essence and in relations. The conditions of commercial intercourse were abruptly and fundamentally altered, and a veritable new world of energy and opportunity invited the conquest of the race.

No other triumph over the forces of nature compares with this in its influence upon human environment. It has directly and powerfully affected the direction and volume of commercial currents, the location and movements of population, the occupations and pursuits in which the masses of men are engaged, the division of labor, the conditions under which wealth is accumulated, the social and industrial habits of the world, all the surroundings and characteristics of the associated life of to-day. The world has seen no change so sudden and so amazing.

The next fact to be noted is hardly less remarkable. Not only are the new methods of transportation incomparably superior in speed, cheapness and capacity, but, unlike those

which have been supplanted, these new methods are themselves capable of indefinite increase and expansion. The maximum efficiency of an animal is so well known as to amount to a constant quantity, and this unit of power is virtually unchangeable. Substantially the same thing is true of a vessel of given dimensions and given spread of canvas. For this reason distribution remained, as I have said, the one fixed and inflexible element to which all other activities, however elastic and progressive, were necessarily adjusted and by which they were limited.

Now, a special and most suggestive feature of transportation by steam, electricity, and other kinds of mechanical force is that its capacity is not only unmeasured and unknown, but will doubtless prove to be practically inexhaustible. That is to say, no certain limits can be assigned to the operation or effect of these new agencies as compared with those which have been superseded. Therefore, speed may reach many times the rate now attained, the size of vehicles may be greatly increased and the cost of carriage for the longest distances reduced to an astonishing minimum; so that as progress goes on in developing the means and methods of distribution, the habits and needs of men will be more and more modified, with consequences to social order and the general conditions of life which may be far greater than have yet been imagined.

But this is not all. Another fact is still more wonderful. Coincident with this sudden transfer from animal power to steam have come the new and amazing means of transmitting intelligence. In a brief generation the barriers of time and distance, hitherto so formidable, have been swept away by telegraph and telephone. No longer limited to the agencies by which material things are transported, we send our thought and speech with lightning swiftness to the four quarters of the globe, and hold all lands and peoples within the sphere of instant intercourse. So recent is this miracle that we are still dazzled by its marvels without realizing its tremendous import.

That this substitution of steam and electricity as the instruments of commerce and communication has been an im-

measurable gain is witnessed here and everywhere by half a century of unparalleled progress. Along these wondrous pathways the world has literally leaped. Released from dependence on beasts of burden, the entire realm of industry has been quickened and enlarged; productive energy has been vivified by new and limitless means of distribution; the products of the whole earth are embraced in wide circles of exchange; all the luxuries of all lands are brought to every household; wealth has multiplied until we are almost surfeited with its abundance, when other people possess it; the genius of invention has been stimulated to larger exercise, the sphere of thought grandly extended, the impulses of charity awakened to nobler activity, while keener sympathy through closer contact is pointing the road to real brotherhood.

But these manifold benefits have not been secured without many and serious evils. The potent energy which produced such prodigies of utility and convenience has generated an array of forces which already test with severe strain the structure of modern society. So radical a change in the methods of distribution, and consequently of production, was sure to be attended with peril as well as beneficence, and to entail a series of results, immense and far reaching. Passing by those acute abuses which are incident to the process of development, which are transitory and must gradually disappear, we may well consider the more profound and permanent effects, what I venture to call the economic effects, of present and future methods of transportation and intercourse upon the whole range of social activity. This brings into view again the impressive fact mentioned at the outset, and suggests some graver consequences than those that appear on the surface and appeal to ordinary observation.

When movement was measured by the strength and endurance of animals, only a limited area could be reached from a common center. Its slowness and expense confined all inland distribution within narrow bounds. Only eighty years ago it took a week to send a letter, and cost $125 to move a ton of freight, from Philadelphia to Pittsburg; and the average price for carrying the necessaries of life was not less than twenty cents

a ton for each mile of distance. On such a basis most commodities were shut off from distant markets, and farm products, for example, would seldom permit of conveyance more than 100 or at most 150 miles. Only such articles as were of small bulk and weight compared with their value were moved to any considerable distance from the place of production. For this reason the requirements of an ordinary family were almost wholly supplied from near-by sources. And this means—without amplifying the statement—that productive energy, for the most part, was restricted by the consuming capacity of the surrounding neighborhood. The forces outside each little circle were but feebly felt and had slight influence upon its separate affairs. Broadly speaking, the business of each locality was adjusted to its own conditions and was practically undisturbed by like operations in other places. What we call competition was held in check by slow and costly means of conveyance; its effects were moderate and limited, its friction seldom severe.

But the use of steam for motive power and electricity for sending news increased enormously the range of accessible markets, and at once intensified competition by the celerity and cheapness of distribution. Industrial strife has already become world-wide in extent and distance an ineffectual barrier against its destructive assaults. For distance as a commercial factor is not at all a matter of miles, it is merely a question of time and money. So the effect of cheap conveyance and quick communication is to bring remote places closer together. For all the practical needs or enjoyments of life Manila is nearer New York now than Montreal was a century ago; and the whole world could be easier governed from Washington to-day than could the United States when the capital was located on the Potomac.

Our grandparents got their supplies mainly in the neighborhood where they resided, and only a few persons were concerned in their production. To-day it may safely be said that five millions of people and five hundred millions of capital are directly or indirectly employed in furnishing a family dinner. When merchandise of every description is moved by the ton

at great speed from one end of the land to the other, and at a average cost of less than three-quarters of a cent a mile, as is now the case, the expense of transport is but a trifling impediment to the widest distribution.

Nor should we forget that it was the opening up of new and ever enlarging markets, by the cheapness of steam transportation, which gave the first opportunity for the extensive use of machinery; and this in turn quadrupled the capacity of labor and greatly reduced the cost of large scale production. By this revolution in the methods of manufacture—caused by the railroad and steamship—the mechanic was supplanted by the operative, and the skilled and independent craftsman of former days found his occupation gone. For what chance now have hand-made articles when the factory-made product is carried across the continent at nominal cost? But the factory without the railroad would be only a toy shop. If its wares had to be hauled over country roads by mules and horses, the points they could reach would be few and near by, and thus contracted sales would limit the size of the plant and the volume of its business. It is simply because transportation is now so speedy, so cheap and so abundant that great establishments have become profitable and driven their smaller rivals from the field.

These facts—which might be multiplied without limit—bear directly, as I think, and with a force not fully perceived, upon the whole problem of industrial competition. The argument runs this way: As the means by which industrial products are distributed become more convenient, quicker in action and less expensive, the area of distribution rapidly enlarges, and as the area of distribution enlarges the competition of industrial forces increases in something like geometrical ratio. The movement of property by rail in the United States alone already exceeds four millions of tons every twenty-four hours. Think of the rivalry of products, the strife of labor, the strain and struggle of trade, which such a movement implies. With the constant acceleration of that movement, which is certain to happen, how long can the friction be endured? How soon will it become unbearable?

The truth is that new conditions have arisen and new methods must be adopted. All the pressure of modern life impels to

the coordination of effort. We see that discord and antagonism, to say nothing of their moral bearing, have far less efficiency than harmony and cooperation. The world is searching for economies. It is intolerant of needless expense. The way a thing can be done the easiest and cheapest is the way it is bound to be done and the way it ought to be done. We want the best results and find that they come from combination. The old aphorism, "in union there is strength," takes on a new meaning. It is the law of growth and increase. It applies to industries as well as to individuals. To unite is to advance. The concentration of process is the expansion of output.

Thus the potent agencies by which distribution is now so rapidly and cheaply effected, which so combine and intensify the forces of production, are fast altering the conditions and changing the character of industrial development. And the end is not yet; it outruns imagination. What will be the ultimate effect of these methods of conveyance and intercourse when brought to higher perfection and employed with still greater efficiency When these agencies of commerce are increased in number and capacity, as they will be; when cost is still further and greatly reduced, as it will be; when speed is doubled, as it will be, and quadrupled, as it may be; when the whole United States shall have reached the density of population now existing in Great Britain—how can industrial competition possibly survive?

When Adam Smith wrote "The Wealth of Nations," it took two weeks to haul a wagon-load of goods from London to Edinburgh, and such a thing as a business or industrial corporation was virtually unknown. To-day the great enterprises of the world are in the hands of corporations, and the time is fast approaching when they will absorb all important undertakings. Why? Simply because the railroad and the steamship—cheap and rapid transportation, all the while growing cheaper and quicker, ever widening the area of profitable distribution—furnish the opportunity, otherwise lacking, for the employment of larger and still larger capital. This opportunity permits and encourages the concentration of financial resources; so that, within limits not yet ascertained, the larger the business the

greater its possibilities of gain. But the legitimate, the inevitable offspring of corporations is monopoly. Why? Simply because the operation of these massive forces—reaching and opposing in every market of the world—begets an extremity of mutual danger which always invites and often compels a common agreement as to prices and production, that is, a trust. Just as the implements of warfare may become so devastating in their effects that nations will be forced to live in amity, so the destructiveness and exhaustion of commercial strife in these larger spheres of action will make combination a necessity.

So, in the measureless and transforming effects of modern transportation, and the ends to which it resistlessly tends, I find the primary cause of the economic revolution upon which we have entered. The incoming of these new and unfettered forces not only changed the basic function of society, but greatly disturbed its industrial order. In the effort to restore a working equilibrium strange questions arise and novel difficulties are encountered. Already we are compelled to doubt the infallibility of many inherited precepts and to reopen many controversies which our grandsires regarded as finally settled. The ponderous engine that moves twice a thousand tons across an empire of states, the ocean steamer that carries the population of a village on its decks and the products of a township in its hold, the vast mergers of producing and distributing machinery whose colossal grasp covers land and sea, are indeed splendid evidences of constructive genius and financial daring; but more than this, they are economic and social problems whose complexity bewilders and whose magnitude dismays. They force us to discredit the venerable maxim that "competition is the life of trade," and warn us, I think, that the political economy of the future must be built on a nobler hypothesis. If it be true in the long run, as I believe experience teaches, that where combination is possible competition is impossible, is it not equally true that combination becomes possible just in proportion as transportation becomes ampler, speedier and cheaper? So the opportunity, if not the necessity, for combination has already come in many lines of activity and will certainly come in many more. For the circumstances that permit competi-

tion, its *sine quà non*, are mainly difference of conditions. Practically speaking, this difference is chiefly found in the means of distribution. As that difference disappears, with the constantly diminishing time and cost of transport, the ability to combine will increase and the inducement to do so become overwhelming. That seems to me the obvious tendency of industrial and social movements to-day and that tendency, I predict, will be more and more marked as time goes on.

How fast the process will develop, or what phases it will assume, does not yet admit of confident forecast. Many experiments will be tried, many failures occur, before the readjustment is accomplished. Remedies will be sought in profit-sharing, in the distribution of corporate stocks among employees, in the socialization of public utilities, in largely increasing the functions of government. By whatsoever road reached, the ultimate if not early outcome will probably be some form of centralized control with diffused or decentralized ownership. Meanwhile, the exactions of monopoly, the feebleness of legal restraints, the heaping up of fabulous fortunes, the prejudice of the ignorant, the envy of the incapable, and through all and over all the inappeasable voice of labor demanding, not without reason, a larger share of the wealth which it produces.

That these great consolidations are wholly desirable I certainly do not pretend. On the contrary, they occasion much cause for regret and not a little for grave apprehension. The utilization of new forces, the transfer to new methods, the control of producing and distributing agencies by huge combinations, must in the nature of the case inflict many hardships and involve many surrenders. But a great principle underlies this movement, the principle of industrial peace and efficiency, the principle of cooperation. Beside all question that principle is to govern, despite all drawbacks its operation will be beneficent.

So, in the unrest and discontent around us, deep-seated and alarming here and there, I read the desperate attempt to avoid the effects of industrial competition and a tremendous protest against its savage reprisals. Every trust and combination, whether organized by capitalists or by artisans, every strike

and lockout, is a repudiation of its teachings and a denial of its pretensions. The competitive theory may have answered the age of mules and sailboats and spinning-wheels, but it fails to satisfy the interlacing needs, or to sustain the interdependent activities, which are founded on modern methods of intercourse and distribution; it is a theory unsuited to the era of railways and wireless telegraphy, this era of ours, so restless in thought, so resistless in action.

I much mistake, therefore, if we are not entering upon a period of great transitions, a period of difficulty and many dangers. The whole structure of industry and social life is liable to be subjected to a strain—possibly to a shock—for which experience furnishes no guiding precedent. We have settled the administrative questions; we can collect taxes, build courthouses and pay the policeman. We have settled the political questions; the nation lives and will live, the greatest and grandest in all the earth. But the further test is now to come, the test of the ocean liner and the limited express. Can we settle the economic questions? Can we raise this wide realm of industry from selfishness to charity, from strife to friendship, from competition to cooperation, from the warring instincts of the savage state to the larger and nobler needs of associated life? This is the problem of railroad and steamship, of telegraph and telephone, of the subtle and limitless forces of modern life, the problem which will test the wisdom of statemanship and tax the resources of public authority.

REPORT OF THE SECRETARY OF SECTION I.

THIRTY-FIVE papers were on the printed program, of which seventeen were read in person, seven by title with abstracts of contents presented, and eight papers were never forwarded by the authors for various reasons. The statistical paper by Professor Arthur Lefevre on "Public Education in Texas," arrived too late for use.

Professor W. R. Lazenby's paper on "Relations of Forestry to Soil and Climate" will appear in the *Proceedings* of the Ohio State Forestry Society at some future date.

Attendance at the meetings ranged from fifteen to fifty persons. Holding the sessions at the board of trade rooms was a mistake. The business people did not attend, and we were too far away from the other sections to admit of their members attending.

Possibilities of Cotton Warehousing from the Producer's Standpoint: Hon. EUGENE WILLIAMS, Waco, Texas.

An elementary principle in political economy is that the raw product should remain at the most available market nearest its field of production until required for actual consumption. Such a policy will save to the cotton belt losses estimated at over $100,000,000 annually from country damage, waste, violent fluctuations in prices, and other unbusiness-like results. The country damage alone to the crop of 1904-5 is estimated at from $5,000,000 to $10,000,000, an amount sufficient to erect a most efficient warehouse system throughout the entire cotton belt. To save these losses for the next and all succeeding crops a warehousing system should be established. This weather damage is a slight loss compared with the costly results which follow the inexperience of farmers as salesmen and the outrageous effects upon the market brought about by artificial influences.

The prices actually paid for single bales of cotton on the streets of a country market town, contrasted with the prices received by farmers who concentrated their several small holdings in a small galvanized iron warehouse in the same town, show that this single warehouse, by bringing under its friendly control a few hundred bales of cotton offered and sold in lots, realized from one-eighth to one-third of a cent per pound, or from 60 cents to $1.60 per bale, more than if sold by the single bale on the farmer's wagon. This rate of increase in price would realize from six to sixteen million dollars on the entire crop.

Therefore, I favor erecting a small warehouse in every town marketing approximately 1,000 bales of cotton, or over, annually, as contrasted with a few large city warehouses, because: (1) The farmer would be willing to hold his cotton in his market town, but would not be willing to ship it to a

distant city warehouse; (2) the farmer would sell his cotton at a loss rather than ship to a distant city warehouse; (3) a local warehouse full of farmers' cotton would bring the increase in price to the farmer, whereas the large city warehouse, full of exporters' cotton, would not help the farmer who produces it; (4) the local warehouse full of farmers' cotton would bring to the local banks for deposit the increased volume of money flowing from the excess in price received by the farmer for his cotton; (5) cotton held by farmers in local warehouses would provide for local banks the best possible collateral for farmers' loans to carry the cotton; (6) the increase in deposits and choice collateral for loans would tend to decrease the rate of interest and multiply manifold the local bank's volume of business and its profits, while serving its customers better and upbuilding its home town; and (7) small warehouses would do more to encourage cotton mills in the cotton belt than all other influences combined. Large warehouses at distributing centers would take care of themselves.

Factors Determining the Price of Sugar: Dr. FRANK R. RUTTER, Washington, D. C.

The remarkable increase of last year of 50 per cent in the price of German raw sugar for exportation was due to a decrease of only 7½ per cent. in the total sugar production of the world. The price of clarified sugar in New Orleans advanced over one cent a pound, but this year has returned to its former level.

The main part of the paper deals with the deviations in the sugar prices of the United States from the world prices as represented by German quotations for export sugar. It is shown that the tariff reductions in favor of sugar from particular islands—from Cuba, Hawaii, Porto Rico and the Philippines— has considerably depressed prices for raw sugar in the New York market during the months from December to June of each year, when these sugars usually more than suffice for the requirements of refining. Louisiana sugars are at a disadvantage from being marketed within this period. From 80 per cent. to 85 per cent. of the total receipts of New Orleans are sold in November, December and January. Besides this, the prices for refining grades are then invariably reduced, from thirteen to nineteen cents per hundred pounds below New York quotations, simply because it would cost approximately that amount to ship Louisiana sugar to New York. But this is merely a relic of the time when large quantities of the Louisiana product were shipped by water to the Atlantic ports. It does not seem to be justified under present conditions, when New Orleans possesses large refineries, has more advantageous freight rates than New York to interior territory, and annually imports between March and September from 100 to 500 million pounds of foreign sugar. The depression in the price of raw sugars by no means causes a corresponding reduction in the price of refined, which is almost uniformly kept above the price at which German refined sugar could be imported after paying the full customs duty.

Relation of Higher Education to the Economic Development of the South: Chancellor J. H. KIRKLAND, Vanderbilt University, Nashville, Tenn.

The relation of economic development to education is most intimate. The work of the world is done by mind, not muscle. There is not enough muscular power available to reap the wheat crop of a single year. Universal elementary education is the first condition of material progress. Industrial training is also desirable for a large class of our population, but such training should develop the head as well as the hand.

1. Universities have largely modified their courses in response to the demands of practical life. Professional courses are offered for the training of engineers, chemists, electricians, manufacturers, and in every science applied courses open to all students the new lines of industrial development. Universities contribute to economic development by fundamental instruction in the general principles of science. Abstract mathematical research lies at the foundation of every science.

2. Universities contribute to economic development also through work done in philosophy, history, political science and economics. We need, as industrial leaders, men of broad sympathies and wide vision. The application of ethics to industry is as important as a new invention or an improvement in machinery.

3. Universities should also propagate sound economic doctrine. They should educate the public. Political education must be coextensive with the ballot. Economic fallacies are peculiarly dangerous when they receive a political embodiment.

4. So far as the south is concerned, its universities have been too poor to fulfil the tasks outlined. Scientific instruction is still meager, and our laboratories poorly equipped. But little is done in the departments of history, economics and political science. The south should take advantage of the experiences of other sections in achieving its great economic progress. For example, we do not need to build up our factory system on the pernicious fallacy of child labor. This question has been fought out in old England and New England. The south has learned the failure of slavery as a source of wealth and child labor is not far removed from slave labor.

5. Politically the south has inherited the spirit of leadership and the traditions of good government. But we, too, have built up an art of politics and developed our machines. We have deified party fealty. But we have yet to work out the reign of intelligence in political life. We have yet to learn that our chiefest political issues are clean, honorable, frugal and efficient administration of the simple duties of public office. We have yet to learn the intimate relation betweeh righteousness, intelligence and economic prosperity.

Teaching Agriculture in Rural Schools: Professor W. F. MASSEY, North Carolina Agricultural Experiment Station, Raleigh, N. C.

1. The agricultural colleges have been greatly handicapped in their

development of efficiency for want of preparatory courses in agriculture in the secondary schools.

2. Though the time is not yet ripe for the general establishment of District schools for agriculture, the great need of the times is some elementary instruction in the form of branches of study applicable to the work of the farm.

3. The next great need is the training of teachers. This is beginning to be met by summer-school courses at our colleges of agriculture. School children's interest should center not only on the natural productions of the locality, but also on the study of the soil, methods of tillage, influence of sunshine, rain and the weather generally on plant life and growth. At the St. Louis Exposition 8,000 specimens of corn were exhibited which that number of boys in Illinois had raised, 1,250 of whom took prizes ranging from 50 cents to $500.

4. The south needs this work especially, and must begin with a kind of kindergarten work with the youngest, to be followed by the school garden work for the older or more advanced pupils. The children of the farmer will see in this occupation the future which they seek—a future which will keep them not only from forsaking the old homstead, but result in multiplying homesteads, where abandoned fields now await the magic touch of scientific intelligence.

Some Problems of Agriculture in Texas: Professor G. S. FRAPS, Texas Experiment Station.

The problems of Texas are on the whole those of a rapidly developing country, a search for men, money, crops adapted to the soil and markets to sell them. The maintenance of the soil fertility is beginning to be of importance. The cotton men have the boll weevil, the boll worm, dead cotton; the rice men, to institute a rotation and soil treatment which will maintain the productiveness of their soils. The cattle men are improving their stock. Fertilizers are being used, and their use is increasing.

Utilization of the By-products of the Cane-sugar and Rice Mills: Professor W. R. DODSON, State Experiment Station, Baton Rouge, La.

Louisiana leads all other states in the union in the production of these by-products, and has done more than has been done elsewhere in determining their real value and encouraging their utilization.

There are three main by-products in the rice mills of Louisiana: rice hulls, rice bran and rice polish. Rice hulls are practically of no value as foodstuffs, while rice bran and rice polish are of great value as such. Rice polish is now worth from $22 to $24 per ton, and it ranks high as a concentrated foodstuff. Compared with wheat bran, it contains 20 per cent. more digestable carbohydrates and 4 to 4½ per cent. less digestable protein. Rice polish is very valuable foodstuff for swine. Rice bran has been greatly adulterated as it rose in public estimation and in value as foodstuff. The adulteration is principally with ground rice hulls, which are practically

of no value as food. Sometimes mixed rice and wheat bran are found for sale on the markets in Louisiana, being sold as pure wheat bran. In these instances analysis reported on rice meal indicated that there had been an addition of rice hulls. The law in Louisiana, which has been in existence for about one year, requiring the manufacturer to tag each sack of bran, giving the composition of protein, carbohydrates, fat and fiber, has served to some extent to check the wholesale adulteration of rice bran.

With regard to the by-products of the sugar mills, molasses, which a few years ago was held to be refuse, and was either given away to be taken out of sight and out of the way, and which often was dumped into the plantation ditches, is now considered a most valuable ingredient in the feed of stock, and is worth at least $8 per ton.

Relation of Schools to Civic Improvement: LOUISE KLEIN MILLER, Curator of School Gardens, Cleveland, Ohio. (Illustrated by stereopticon.)

An instructive description of work done in Cleveland, under public school auspices, with private cooperation, by which many vacant lots were transformed into flower beds and vegetable gardens, especially in portions of the city where such properties are often neglected or used as dumping grounds. Back yards, from being cheerless and uninviting, by proper encouragement of the young as well as the aged, became sources of enjoyment where the first lessons of horticulture and vegetable gardening were learned, thus contributing to the pride and pleasure of the people in their homes as well as to the health and beauty of the neighborhood.

At the end of five years the Home Gardening Association, through which this work is developed, finds its work more widely known and its aim better understood. This is manifest in a number of ways. The occupant of a small house is furnished an incentive to make the yard attractive. The real-estate dealer recognizes the improvement in the appearance of property and appreciates the consequent increase in values. The teachers and school officials, almost without exception, concede the vital interest aroused in the pupil and are ready to make use of this aid to school work. People concerned for the improvement of city conditions are satisfied that this is one of the effective means to secure that most desirable result. Inquiries from other communities are increasing, and, in a number of instances, work along similar lines has been started.

Southern Cotton-mill Workers, Their Condition and Needs: Rev. J. A. BALDWIN, Piedmont Industrial School, Charlotte, N. C.

Before the war the poor white people had very meager educational advantages, and consequently most of them were illiterate. Much has been done for their descendants at the mills, but so much still remains to be done that the situation is really appalling. The public schools are to be found at every mill, and are doing much good, but there is much to be done which they are not doing and can not do. Some kindergartens have been estab-

lished. There ought to be many more. With shorter hours of labor, which are sure to come, special impetus will be given to night classes. But there are thousands of young people who can not read and write, and very few of the others can do much more. They have in them wonderful possibilities, as evidenced by the fact that most of the superintendents and practically all the room overseers have come right up from the lowest places in the mill. These young people are beginning to be interested in education. They are awaking from the sleep of generations. But there are no schools that suit them.

They are too old to go into the schools for young children. They must have their needs met in other ways. In addition to common school courses suited to their needs the boys should have a textile course, and the girls a course in domestic science. The more favored classes have their colleges and universities; the negroes have their Hampton, their Tuskegee and other schools. The cotton-mill people of the south have nothing. A thoroughly equipped boarding school, giving the course as indicated, with expenses low, and giving opportunity for students to work part of the time in the mill and on the farm, will prove of incalculable service to humanity. Such a school has been established as a private enterprise at Charlotte, N. C., the center of the cotton-mill industry in the Piedmont section. After two years the school has an enrollment of 120 pupils. It is working with an endowment of 277 acres of land located in a rapidly growing suburb, where many of the students work half of their time in the mills and attend school the other half. Mr. Baldwin's intention is to establish later, if possible, a small cotton mill, where the students can put in a portion of their time working out their tuition. The curriculum has been arranged with view of adaptation to the needs of the operatives and includes courses in English branches, textile training, agriculture and domestic science.

Industrial Training and the Negro Problem in the United States: Principal E. L. BLACKSHEAR, Prairie View, Texas.

Herbert Spencer's conception of education as the correlating of the human unit to his physical and social environment has grown into the modern complex notion and system of industrial training which is physical on one side and intellectual and moral on the other. Objectively, it is the training of muscular energy and sense-perception in intelligent physical process, directed to a final cause or end; the realization of the ideal; the training of hand and eye. Subjectively, it is the discovery of the means, methods and process by which the ideal is to become real and useful, involving the exercise and development of observation, analysis, discrimination, criticism, choice and will; the formation of the work-habit, with its properties of persistence and fidelity; and the creation of character, with its endowments of self-control, self-culture and self-support in their relation to serviceableness to the general good.

It is obvious that this form of training is just that needed to adjust a primitive people like the ex-African negroes to highly specialized industrialism of the American politico-economic system; it is the training, too, that must be applied to the Filipino and to the African natives if these backward peoples are to become progressive and self-sustaining.

This theory was first put into practice by General Armstrong in a system of training for the emancipated blacks at Hampton, Va. This work gave birth to the Tuskegee Institute, under Booker T. Washington, and established a system of manual and industrial training for the blacks on the only principles which give reasonable promise of a solution of the negro problem involving the enhanced value of the race to American society.

As evidence that it is worth while we cite proofs for the productive value of negro labor. The negroes are doing the bulk of the hard, undesirable labor of the south in all lines—its menial, agricultural and heavy contract work, track-work, grading and excavating, heavy mill and foundry work, and the work of the stevedore. They do some of the work of the mechanic and probably the bulk of the hard work connected with the culture of cane, cotton, sugar, tobacco and rice.

Further, negro labor is the most effective cheap labor and the cheapest effective labor the south can get; and the whole country is calling for labor. If it were not for European emigration, the United States would be at a great economic disadvantage. But immigration may not continue always and in the keener competition of the future between the commercial nations, the labor of the negroes may be very useful.

As to the relation of training for negroes to the race problem, that is, to the problem of how best to maintain normal and helpful relations between the whites and the blacks, it can be said that industrial training will help to better relations by making negro labor useful to the white employer of labor and hence more necessary to the successful conduct of the business and industrial operations of the south. The chief complaint made against negro labor has been that it is not prompt and not regular, faults which training will remedy.

By way of summary, the applicability of industrial training to a race in the condition of the negro; the industrial capacity of the race as shown by the African tribes and ex-African slaves; the testimony of the existing poorly equipped negro industrial schools; the present distribution of negro laborers among American industries and their relative success in them; the extent to which the south uses negro labor in domestic, industrial and agricultural lines; the large acreage of southern farm lands worked by negro farm labor; the large per cent. of negroes engaged in the useful industrial pursuits in all parts of the Union; the eagerness of the negro youths to secure industrial training; the sentimental and historic obligation of the American people to the blacks in view of their responsibility for their presence in America; the economic debt the nation still owes them for generations of unrequited labor and for tremendous present

values accruing from that labor—these and other considerations point to the industrial training as the need of the hour for the negro people, and as the solution of the race problem, as well as to the duty of the nation through federal agency to make provision for the establishment of a chain of schools to accomplish this great and beneficent purpose.

Social Work of the General Federation of Women's Clubs: Mrs. A. O. GRANGER, Chairman Child Labor Committee, Cartersville, Ga.

The General Federation was organized by Sorosis in New York City in March, 1889, and now includes working clubs in Alaska, England, India, China, Hawaii, Mexico, Porto Rico, Chili and Western Australia. The central point toward which all its work tends is the *child.* The men and women of to-morrow are the children of to-day, and everything that tends to make the conditions of child-life better is of importance. As a federation it seeks to coordinate the great variety of women's clubs upon this central aim, and its policy is best expressed by its motto—unity in diversity. It seeks to enable the less fortunate to share the enjoyment of the better things in our civilization. It avoids fields already covered by social effort and trains its members to fill the gaps and to do the work neglected by others.

Among its most active committees are one to develop true art in school work; another to further the use of good literature, working with the committee on library extension among our schools; a third on household economics for the better conduct of home affairs from the business standpoint. The pure food committee quickens the public conscience against adulteration. The civic committee occupies itself with several lines of work—sanitation, training for citizenship, municipal morality and the beautification of the city. Its committee on civil service reform helps to mold the sense of official honor. The committees on forestry, on education, industrial conditions, on child labor, have helped to develop an enlightened public opinion on all these vital questions in an effort which covers the entire country.

Progress of the Negroes of Virginia as Property Owners: CHARLES E. EDGERTON, Washington, D. C.

This is an examination of the rate at which property has been acquired by the negroes of Virginia, with especial reference to the question whether the economic character of the present generation of negroes, as indicated by this test, is inferior or superior to that of the generation which was trained in slavery and freed by the war. The data are derived from the census and from the local assessments for taxation. The property of negroes was first shown separately on the assessment books in 1891, and the last assessment here used is that of 1903, giving an interval of twelve years.

The number of negro farmers in Virginia who owned their farms free of encumbrance in 1890, according to the census, was 13,097. If we assume

that the negroes started without property in 1865, the number of negro farmers in the state who acquired full ownership of their farms between 1865 and 1890 amounted on an average to 524 a year. But during the next ten years the number was 913 a year, or 75 per cent. greater. If all farm owners, mortgaged as well as clear, are included, the number was 547 a year from 1865 to 1890, and 1,394 a year, or two and a half times as many, from 1890 to 1900.

On the same assumption that the negroes had no property at the close of the war, the assessments for taxation indicate that they acquired 26,000 acres of land a year from 1865 to 1891, and 38,000 acres a year, or almost half as much again, from 1891 to 1903; and rural buildings to the value of $53,000 a year from 1865 to 1891, and to the value of $110,600, or more than twice as much, from 1891 to 1903.

In proportion to their numbers, the negroes increased their acreage of land, and the total value of their rural real estate, two-fifths faster from 1891 to 1903 than from 1865 to 1891, and the value of their rural buildings twice as fast.

The number of negro farmers who owned their farms clear of encumbrance in 1890 was only 26 per thousand of rural negro population, according to the census; in 1900 it was 42. The negroes had only a third as many unencumbered farm owners as the whites in proportion to their rural population in 1890; in 1900 they had half as many.

The assessed value of town real estate owned by negroes was $4,650,000 in 1891, and $6,350,000 in 1903. It increased in considerably greater ratio than the town negro population, while the assessed value of the town property owned by whites did not increase in so great a ratio as the white town population.

In Virginia, at least, the negroes have increased their property holdings more rapidly since the ante-bellum negroes ceased to be an important economic factor than they did while the older generation occupied the stage. In view of this unquestionable statistical fact, it can hardly be doubted that the economic efficiency of the present generation, at least in Virginia, is greater than that of the generation that was trained in slavery.

Railway Conditions in Texas: O. B. COLQUITT, State Railway Commission, Austin, Texas.

How much of the stock and bond issues of Texas railroads is "fictitious" no man can tell without access to the old books of the companies, almost all of which have passed through the "wrecking" period, and in many instances new companies formed to take over the property of the wrecked company. The total of stock and bonds outstanding June 30, 1893, the year the stock and bond law went into effect, was $392,726,113 on 9,198 miles of road, an average of $40,250 per mile. The commission's estimate of what it would cost to reproduce all the railroads in Texas on June 30, 1904, was $16,244 per mile. The estimate was made

on what it would cost to reproduce the roads—the old roads—in their condition at the time they were valued, the materials, cost of labor, right of way, etc., being figured at average prices prevailing at time of valuation. On the average estimated cost of reproduction, the 9,198 miles of operated railroad in 1893 were worth $149,422,312 showing $243,303,801 of the outstanding bonds and stocks to have been "fictitious."

Management, under apparently like conditions, has much to do with state railway regulation. They had equal privileges conferred. Of three examples cited, the first is laid in a populous, rich section, running from north to south, and the earnings and accumulations have been great. Years of operation make a good showing of surplus which is in the hands of its owner in New York.

The second, running from south to north, in a rich and populous section of the state, had a large income from operation, but either spent it in "riotous living" or so merged it with that of its dominant owner as to show a condition of bankruptcy on its own books.

The third is in a sparsely settled part of the state, unassisted by domination, and aided alone by its own energy and prudence, and with the same rates prescribed by the state for the others, has prospered, and distributed its surplus earnings to the numerous holders of its shares of stock. Which of these three do you say has employed its privileges to the best advantage and to the greatest credit of the state?

This brings us to a discussion of freight rates. What is the proper basis for ratemaking? Shall they be fixed with reference to the capital invested? Should they be made with reference to the value of the commerce transported? Should they be fixed upon the theory that they should be "all that the traffic will bear?" Or must they be fixed and adjusted so as to pay all fixed charges, operating expenses, betterments, etc., and leave something for the stockholders.

If the latter basis should be adopted how would you adjust the rates to meet the showings made by the three roads I have taken for illustration? The management of one road might, on the same rate, with the same tonnage, same capital and investment, make money, and another lose. You can never fix rates that will be reasonable to the shipper on that basis unless you have control of the finances and operate the line independently. One Texas line paid out $30 per 100 train miles for maintenance of equipment, while another paid only $15 last vear.

If you base rates on the theory that they shall be "all the traffic will bear" the movement of freight on such rates will be restricted to the actual, economical requirements of all freight-paying commodities. Such a rule will not stimulate the movement of commodities of small value.

From what I have already said it is also conclusively shown that you can not use the bond and stock issues of the roads as the proper basis for rate-making.

Proposed Solutions of the Railway Rate Problem: H. T. NEWCOMB, Washington, D. C.

This paper applies especially to commercial rates as related to the work of the interstate commerce commission. This commission is a federal agency of high authority and the law under which it exists is a broad and comprehensive statute which has strongly influenced the economic life of America since its enactment in 1887. It forbids every unreasonable interstate railway rate and every undue discrimination among rates, and the commission has the right to condemn any unlawful rate or practice. Much of the work of the commission is accomplished through its agencies for publicity and by conciliation; at least eighty per cent. of the complaints it receives are settled by its informal and mediatory action; seventy per cent. of its formal orders are voluntarily obeyed. In nearly nineteen years only forty-seven cases of disobedience to its orders have been presented to the courts, and of the thirty-five final decisions rendered all but four have been that the order disobeyed was unlawful. In four cases the orders have been enforced by the courts, thus proving that the power exists when the commission acts lawfully. In addition, the Elkins law has proved a prompt and effective remedy for unjust discrimination.

So much for existing law. Many proposals for new legislation are now before the congress and the people. This paper has been prepared especially to point out certain broad principles in connection with them. The measures proposed fall plainly into two classes. There are proposals which contemplate: (*a*) A single act of legislation leaving the enforcement of the law to the ordinary executive and judicial machinery supplemented, as at present, by the interstate commerce commission, and (*b*) successive acts of legislation, each specially adapted to the conditions peculiar to a particular case.

The conclusion reached from a study of existing methods and conditions is that, with our laws as they are, there is no genuine instance of injustice in interstate railway rates which can not be remedied under the present law, and that the existing remedies can be applied as promptly as those which government provides or can provide for wrong of any sort when the interests concerned are of great magnitude. To adopt the other theory would be to rely on law-made rates instead of rates determined by the market.

Methods of Developing Traffic, Industry and Immigration by a Modern Railway: J. F. MERRY, General Immigration Agent, Illinois Central Railroad.

The fact that more than 98 per cent. of the $1,975,174,091 collected and disbursed by the railroads of the United States in 1904 was from traffic, and less than 2 per cent. from all other sources, presents a good and sufficient reason why the railroad companies of this country should employ only the best methods of extending this almost exclusive source of revenue. There are many ways by which traffic may be increased, but

the following methods have been, and are still, in use by all modern railroads:

1. A study of the agricultural resources and possibilities of the country on and adjacent to its lines and the encouragement of every legitimate effort to develop them.

2. A careful study of the industrial conditions that obtain in all the territory through which its lines run and the taking of such steps as will permanently locate factories at as many points as practicable for the manufacture of raw material, and the employment of labor and capital.

3. Providing modern equipments and quick service for the handling of merchandise and the products of the farm and factory.

Methods of development by the Illinois Central began with turning its 3,700 acres per mile of road into freight-producing territory. The grant of 2,594,115 acres was marked at from $1.25 to $2.50 per acre. Soon every public highway was lined with covered wagons from New England and the middle states, from Ohio and Michigan, filled with men, women and children as pioneers in the peopling of the prairies along our line, so that by 1870 the state of Illinois was nearly as densely populated as the east. Before 1880, the fruit commission men at Chicago had never seen a consignment of fruits and vegetables from south of the Ohio river. About that time, as the eastern states could no longer supply the west with table luxuries, this road began experiments with strawberries, peaches and other varieties of fruits and vegetables in Tennessee, Mississippi and Louisiana. Much of this was done on cutover forest lands supposed then to be of no agricultural value whatever. The first carload from south of the Ohio over this line reached Chicago in 1881. In 1903 there were shipped to Chicago alone 128 carloads of strawberries from points between Grenada, Miss., and Keener, La., not counting the earlier and later shipments by express. In the same year 1,805 cars of vegetables were shipped north from the same territory, including New Orleans. The road had 35 refrigerator cars of 14 tons each in its entire service when the experiments began; since then the company has placed in the service 2,491 cars of 60 tons capacity, in addition to 1,510 fruit cars, making a total of 4,001 cars. From one point in Louisiana 200 carloads of strawberries, and from another in Mississippi 800 carloads of vegetables, were shipped in one season, as grown on land too poor to be cultivated in cotton and thought to be of no value for anything. These fruits are hauled to market in refrigerator cars provided with springs that make them ride as easily as a passenger coach.

The Restriction of European Immigration: O. W. UNDERWOOD, Member of Congress from Alabama.

During the year ending June 30, 1905, there came into the United States 1,026,000 alien immigrants; a greater number of people than all of the people who came here from Europe between the first landing at Jamestown and the Declaration of Independence, one-eightieth of the people

of the United States; and in ten years at the present rate it would equal an addition of ten million aliens, or about one-tenth of the present population.

From the discovery of America down to the year 1880 the greater portion of the immigrants who settled in North America were from northern Europe. In the meantime the steamship companies had found that immigrants coming to America were a source of large revenue. When they found that this immigration was falling off they adopted artificial means to stimulate it. They found that it was more difficult to induce the people of northern Europe to come to America than it was to encourage immigration from southern and eastern Europe, where the conditions of the people were less favorable, and where they were more willing to leave their old homes. The result has been that the character of the immigration since 1880 has almost entirely changed; out of total immigration for the year ending June 30, 1905, of 1,026,000 people only 221,019 were of Teutonic origin and 124,218 of Celtic origin. The balance were of Iberic, Slavic and Mongolian origin mostly. Ultimately we must assimilate and absorb these peoples.

We are now getting the weakest of European peoples, instead of the strongest. The steamship companies are indifferent to the quality of immigration if they can only get the quantity. There is scarcity of labor, to be sure; but many of our best citizens are moving to Canada to escape competition with these very immigrants at home. The remedy is a head tax, increased from two to twenty-five dollars, to prevent assisted immigration, and a requirement to read and write the constitution of the United States in some language.

The Jews in Russia: Their Economic and Social Position: DR. I. M. RUBINOW, Washington, D. C.

Of the five millions of Jews living in Russia, 95 per cent. live in the pale—that part of Russia in which Jews are permitted to live, and which constitutes only one-fifth of European Russia. Only rich business men and professional people are permitted to live outside the pale. Even within the pale a Jew may not live outside the city limits. Many professions and trades and even agriculture are practically forbidden fields. In high schools and universities the Jews must not exceed a small percentage of the total number of the students. Petty commerce and hand trades and factory labor are, therefore, the only occupations left open to the majority of the Russian Jews. The result is congestion in these trades, cut-throat competition and poverty. To these conditions the Russian government intentionally remained blind and encouraged the preposterous claim that the Jews were prosperous exploiters of the Russian people, using the prejudice against the Jew as a safety-valve of the popular discontent, and not stopping short of direct organization of anti-Jewish riots, whenever the discontent became very acute.

But out of these abnormal conditions the remedy is gradually evolving. The poverty and congestion of the towns in western Russia produced a free labor market, which stimulated growth of manufacturing industry. And factories brought with them a powerful labor movement, more powerful for the many battles it had to wage, the battle of the Jew, of the Russian citizen and the horribly exploited working man.

An organization was formed seven years ago, the so-called "Bund," which combined all these elements, and the results of its short activity are wonderful. It shortened the labor day from sixteen hours to ten or eleven, raised the pay of the working man and commercial employees about fifty per cent., and besides this narrow activity, has taught the Jews to stand up for their rights, to demand and not to beg reforms, to organize in self-defence against the anti-Jewish excesses, and what is more important, to create a strong movement for a free democratic government in Russia. The movement inevitably had far-reaching psychological effects. The patient, suffering and defenseless Jew of olden days was transformed into the energetic fighter for civic liberty, the enthusiastic labor-union man. The Russian Jew has finally regained his self-reliance and self-respect.

These important changes have a significant bearing upon the question of Jewish immigration into the United States. The Russian Jew, having determined to fight for his rights in his own land, is sure of accomplishing his purpose in the not distant future, and the victory will greatly diminish, if not altogether stop, the Jewish immigration to the United States. In the immediate future, however, due to the awful events in the southern cities, the current of immigration will continue unabated for some time. But the Jewish immigrant, being an ardent union man and enthusiastic warrior for the rights of labor, the usual objections against the immigrant from eastern Europe can not be applied to him; the new Russian Jewish immigrant is not a danger, but a powerful ally of the American working man in his struggle for economic and social betterment.

The Child-labor Problem: A Study in Degeneracy: A. J. McKELWAY, Assistant Secretary, National Child Labor Committee, Atlanta, Ga.

The conditions of the child-labor problem in England at the beginning of the nineteenth century and in some of our American states at the beginning of the twentieth are so much alike, that the foreseeing of the same result is inevitable. Certainly there is no more pressing subject for consideration for patriot or philanthropist than the welfare of the coming race. As President Roosevelt said to our committee only last month, political questions like the tariff or the currency are insignificant in comparison with a social problem like this. The life is more than meat and the body than raiment. Certainly there could befall a people no greater catastrophe than race degeneracy. It is sufficient to say here that this catastrophe is not only threatening, but already impending.

In the manufacturing states of the north and east the legislative prob-

lem has been largely solved and there remains only the problem of the adequate enforcement of the law. The industry which was chiefly cursed by child labor in England is the characteristic and commanding industry of the south, the manufacture of cotton; and the northern problem differs from the southern in being chiefly a foreign problem. It is the children of the French Canadian and the Portuguese and the Greek that demand protection in New England, the children of the Italian and the Slav in Pennsylvania. No child of American parentage has yet been found at work in the sweatshops of New York city. In the south it is especially an American problem, for it is concerned with the depreciation of the purest American stock on the continent. And this gives another point of comparison between England and the south, namely, the similarity of the racial stock.

The same race degeneracy which progressed for a hundred years in England to its dire culmination is beginning already in the south. There has already been developed in our manufacturing communities a "factory type" easily recognizable, the children distinguished by their pallor and a certain sallowness of complexion. Early employment tends to independence of parental restraint. The breadwinner becomes a man too, and early marriages are the rule. The wife and mother continues her work in the mill, since the wages of the husband are not enough for the support of the family. What must be the children born of such unions and their children? Diseases of the throat and lungs are common and also diseases peculiar to women brought on by employment long continued at the critical period of a young girl's life.

We must save these children for their country. We must protect them from the consequences of untimely toil, the sapping of physical vitality, the marring of the mind and the spoiling of the spirit that come with the denial of the rights of childhood.

Why Advancing Civilization in America Increases Crime: Some Methods of Relief: Judge N. B. FEAGIN, Birmingham, Ala.

To train the citizen to live aright, to observe the moral and physical law, so that mankind may attain the highest possible perfection in physical, mental and moral manhood, is the duty of organized society. The Duke of Argyle in the middle of the nineteenth century said that the home, the church and the state were England's greatest civilizing factors. The state, through wise laws, justly interpreted and properly administered, can assure the citizen the protection of life, liberty and property, and the pursuit of happiness. The wisest economy for the state is the greatest care and culture of the citizen from birth to death. This gives strength to good character and force for good citizenship that will exalt the nation.

Recapitulation of Causes.—(1) Advancing civilization increases crime, because of irrational methods. (2) By dealing with results instead of causes, relying more upon repression and reformation than upon formation and prevention. (3) By allowing officials interested pecuniarily in

the arrest, confinement and conviction of offenders to have supervision over them. (4) By releasing offenders upon society worse morally and physically than when arrested.

Some Methods of Relief.—(1) Quicken the public conscience for the amelioration of social and economic conditions. (2) Remedial legislation in providing juvenile courts, detention homes and schools, probation system or suspension of sentence and the indeterminate sentence. (3) Efficient, intelligent and humane officials for the proper enforcement of these laws. (4) The substitution of salaries for fees for officials who deal with offenders. (5) Reliance upon formative and constructive methods rather than adherence to repressive and retributive ideals of justice. (6) A thorough revision of our legal provisions and methods of administration so as to relieve the state of the odium of participation in the creation of criminals.

These methods have passed the experimental stage; they are in accord with the dictates of law and philosophy, of science, morality and religion; and if adopted and wisely enforced in all our states, civilization will continue to advance and crime will decrease.

Race Degeneracy: Professor JEROME DOWD, Wisconsin University, Madison, Wis.

Among savages the degenerate and defective individuals were considered bewitched and hence speedily put out of the world. Even down to the eighteenth century mental and corporal afflictions were largely explained as demoniac possessions. The development of hospitals for the insane gave rise to the science of psychiatry and the effort to trace insanity to natural causes. Then the success of the psychiatrists stimulated the criminologists to inquire whether the moral perversities of the thief, the forger, the murderer, etc., were not also the result of inherited physical and mental defects. A still further step in the study of degeneracy was to inquire if the man of genius was not also, as the insane man and criminal, the result of a deteriorated physical or mental organism. Lombroso in Italy and Nisbet in England have attempted to show a necessary connection between degeneracy and genius. Nisbet cites in his book a long list of great men with the peculiar evidences of degeneracy which characterized each of them. Shakespeare, he says, belonged to a very degenerate stock, the average length of life of the children of his parents being only thirty-two years, and he himself died of a sort of "epileptic seizure." Milton was blind at the age of forty-four years, and his daughter Anne was lame and otherwise defective. Only one of his daughters had offspring and she gave birth to ten children, of whom only three lived to attain adult age.

Advancing a step further in the study of degeneracy, Max Nordau, in Germany, has attempted to show that degeneracy is not a peculiarity of criminals, lunatics or men of genius, but that it is characteristic of all modern civilized races. Many of our celebrated men have all the special stigmata of the criminal or lunatic, but they manifest their defects in a

way which escapes general notice. They are, however, no less injurious to society. Instead of using the knife of the assassin or the bomb of the dynamiter, they use the pen and pencil.

Some sociologists, as Gumplowicz and Le Bon, have taken up the idea of degeneracy and declare that modern civilizations are destined to an inevitable decay and death.

Are there any reliable facts which would support the argument in favor of race degeneracy? Examining into the statistics of the insane, blind, deaf and criminal, the data are so imperfect that it is impossible to say whether conditions are becoming better or worse. The signs of family degeneracy are more serious than those of physical degeneracy or crime. There is no doubt about the increase of divorces and in many countries there is an increase of illegitimate children. Adultery seems to be less offensive now to public sentiment. The New York committee of fifteen recommended its erasure from the category of crimes. Abandonment of children to institutions suggests Plato's state control of childrearing. In France 80 per cent. of the juvenile male criminals are illegitimate.

In spite of all the facts bearing upon degeneracy there are as yet no positive evidences of degeneracy and no occasion for alarm, but the present conditions and tendencies are far from satisfactory.

Economic Aspects of Accounting and Auditing: F. W. LAFRENTZ, President American Audit Company, New York.

Many states of the union have passed appropriate laws under which accountants may qualify and obtain certificates from proper governing boards.

Accountancy is not only applied mathematics, but also applied economics. The accountant must know the theory of values in order to properly understand his profession; and here is where he must consult the economist. He should guard against becoming a theorist pure and simple, however. It is necessary for him to be practical in the application of theory. He must know, for instance, when to stop in his analytical work, so as not to burden a business with detail that it is unable to carry. In other words, he must learn to adapt system to business and not business to system.

The documents in which the accountant sums up (epitomizes) the transactions recorded for any given undertaking are the balance sheet and the profit-and-loss account. The balance sheet shows, on the one hand, the goods that are owned by the business, and commonly described as assets. Now, the setting up of the assets in the balance sheet means merely the making of an inventory of the things owned; but in order to do that the accountant must set a value upon them. Here is where the knowledge of the accountant is put to the severest test. Not only must he know the valuation of all marketable staples, but he must know how to deal with the difficult problems of used machinery, dilapidated buildings, and that most elusive of all assets—good-will.

On the credit side of the balance sheet he will set up the debts for which the goods owned are a lien, so to speak, and which in case of liquidation must be deducted from the results gained in the disposition of the goods. If the goods are more than sufficient to meet these liens, the residue will be the net worth of the proprietor, the capital of the proprietor. The balance sheet therefore, states the *condition* of wealth.

The net worth of the proprietor at a given time, when compared with his net worth at a different date, will show the increase or decrease in his wealth—or his profit or loss during the interim—and the reasons for such change will be found in the profit-and-loss account, for it states the *flow* of wealth during a given period.

This account sets forth six features: (1) The business done as a whole and by departments; (2) the cost of sales, on the same basis; (3) the gross profits, on the same basis; (4) management expenses, which should not vary greatly with the volume of business; (5) profit or loss on the theory that sufficient capital is invested in the business; (6) the net result profit or loss, after all allowances.

Here, then, we find mathematics and economics going hand in hand in aid of the accountant; for in the theories on which he bases his mathematical conclusions we recognize the theories of the science of economics. The themes of the economist, such as capital, profit, income, expenditure, value, property, labor, are the terms employed here. The forecasts of the economist, based upon economic principles, are brought into contrast with the actual results attained by the accountant. These results ought to be studied by the economist, so that he may keep abreast of the times because the factors in the production and distribution of wealth change, and calculations based upon ancient conditions must necessarily be modified.

Honest, Safe and Economical Life Insurance: L. G. POWERS, Bureau of Census, Washington, D. C.

Fundamental principles on which life insurance is based.

Some important facts relating to life insurance.

Life insurance, to be honest and safe, must fully recognize the scientific facts on which all such insurance is based.

These facts most fully recognized by the so-called old-line insurance companies.

Statement of the practical workings of insurance in such companies, by which they can furnish honest, safe and economical life indemnity.

Conditions under which assessment and fraternal insurance companies are unsafe agencies for securing life insurance, and also under which they may be trusted for furnishing the same.

Limited-term insurance the best form for those needing large life protection but who are temporarily receiving very limited incomes.

Old-line insurance with low expense of management preferable for all who have an income permitting of the accumulation of savings, and who wish insurance for a long term of years.

Old-line insurance with present large expenses of administration less desirable for the average individual for caring for savings and securing insurance than the best managed fraternal insurance companies.

Fraternities will become more scientific in their management and accumulation of reserves, and old-line companies will in time become less expensive in their management, and by both classes of companies the public will come to have more economical life insurance as well as honest and safe insurance.

The Census Returns on Manufactures: EDWARD ATKINSON,* Boston, Mass.

The classification of manufactures by the Federal Census leaves much to be desired in the following respects: (1) The collective branches of industry which are conducted in large factories and workshops by great division of labor, distinctly manufacturing, according to the conventional use of that term; (2) the arts which are conducted by the use of modern tools and appliances, but yet remain distinctly mechanic arts, calling for the guiding hand of the artisan, notably the building trades; (3) the lesser branches of industry, both manufacturing and mechanic arts, conducted in small shops by combination of mechanism, improved tools and hand work.

A careful study may enable economists to establish very valuable deductions when these facts and figures are plainly stated. The deduction which I have made from such study as I can give is that the tendency is toward individualism rather than collectivism. That is to say, the arts which are conducted by large numbers of persons under one roof, subject to great division of labor, are becoming more and more automatic, and although giving employment to a large aggregate in each decade, they are giving employment to a less proportion of persons occupied as the decades go by. In some arts one can foresee the time when the only persons occupied will be those who keep the machinery in order and there may be none of the class now called operatives to attend to the product. On the other hand, the arts which require individualism, capacity, mental energy and manual skill, like the building trades, and many other of the arts listed under the title of manufactures, are calling for an increasing proportion of a constantly increasing number. I also find in every art that I have investigated a confirmation of the rule laid down by Henry C. Carey and Frederic Bastiat seventy years ago, namely, "in proportion to the increase and effectiveness of capital, the share of the annual product falling to capital is increased in the aggregate, but diminished in its relative proportion; while the share falling to labor or to the workmen and women is increased both absolutely and relatively."

* Born, Brookline, Mass., February, 1827; died, December 11, 1905. Mr. Atkinson joined the American Association in 1880. He has been a constant contributor to *Economic Science*. An incomplete list of titles of articles published between 1877 and 1905, inclusive, credits him with 183 subjects.

I find in the history of every art, the course of which has not been interrupted or broken by tariff taxes (these arts being very few in number), that the persons who do the manual, mechanical work of the nation, constituting in the narrow sense the working classes, have been and are securing decade by decade an increasing share or proportion of a constantly increasing product to their own use and enjoyment.

The Twelfth Census of Manufactures: W. M. STEUART, Census Office, Washington, D. C.

At the census of 1900, when it was found that out of the 640,194 schedules secured, 343,233, or considerably more than half, were for the hand trades or for small shops with an annual product of less than $500, and also that the cost of collecting the schedules for the small shops was about the same per schedule as for the factories; for this and other reasons given in part 1 of the report of manufactures, it was recommended that these industries be excluded from the twelfth census.

To recapitulate, the reports of the twelfth census show:

1. A clear demarcation between the neighborhood and mechanical trades and the factory industries.

2. There is a provision of law which excludes the neighborhood and mechanical trades from the census of 1905 and it is probable that they will be omitted from all subsequent censuses.

3. All new industries and industries that have developed from the household industries and passed into the factory system, such as the manufacture of textiles, should be considered as a part of the industrial development of the country.

4. The word "manufactures" is defined in the census reports, but its definition cannot be used as a criterion to separate the neighborhood and mechanical trades from the factory industries.

5. The gross value of the annual products of all classes of manufactures can be used to show relative increase.

6. The duplications in the value of products are eliminated in the census reports and either the net or gross value can be used.

7. The average wages should not be ascertained by dividing the total wages by the average number.

8. The number of wage-earners shown in the statistics of manufactures as employed in the different branches of industry can not agree with the number given in the statistics of population by occupations.

Currency Reform and Postal Savings System: DR. M. PIETRZYCKI, Dayton, Wash.

It is proposed to create a special department of the government under the title, " The Bank of the United States," with powers and duties as follows:

A. To issue all national currency, this currency to be full legal tender without restrictions.

B. To redeem, cancel or destroy currency.

C. To organize and operate a postal savings system in connection.

A. The issuing of the currency is to be made only on bond security and under uniform and strict rules: (1) On national bonds, (2) on bonds of the states, (3) on bonds of the irrigation and reclamation districts, (4) on first-mortgage bonds of railroad companies.

B. This would require of the bank proposed that—(1) it redeem in coin any legal currency presented, (2) as new currency was issued present currency including greenbacks should be retired and destroyed, (3) as matured bonds were paid off corresponding proportions of the national currency should be destroyed.

C. Postal Savings System.—The "Bank of the United States" should organize and conduct an efficient postal savings system, receiving, under suitable rules, deposits of money from the people, and paying interest on these deposits at the rate of 2½ per cent. per annum, or less, as may be by the "bank" from time to time determined, and on sums that have been on deposit sixty days or longer.

The government should, therefore, constantly keep a sufficient supply of gold to be able, and must be willing, to redeem the currency on demand.

The Social Service of the Public High School in the South: BRUCE R. PAYNE, Professor of Secondary Education, University of Virginia.

The title of this paper would suggest three topics of discussion. First, what contribution the public high school in the south does and should make (1) to local and national leadership; (2) toward the solution of the negro problem; (3) to the southern industrial problem.

The function of the high school is to select from the public elementary school youths of genius, and train their exceptional powers for leadership.

Participation by southern men as leaders in the affairs of the nation has varied during the last fifty years in direct ratio with the number of high school and colleges and attendance upon them. Is it not probable that the shifting of national leadership from the south to the north and west, has had a causal relation of some sort with the decline of secondary schools in the south from 1850 to 1890? The population of the eleven states of the confederacy is over three times as great as that of Iowa, California, and Indiana, and yet there are nearly 8,000 more high school students in the three western than there are in the eleven southern states. It is also probable that the voices and influences of leading men from the three are more potential than all of those from the eleven. At least a President nominated from one of the three stands a chance of election while one from the south has not in many years.

As a result of the absence of this agency of selection the south has been reduced to a state of national isolation and impotence. Our 25,000,000 people have no representation among the 32 Chairmen of House Committees, no representation in the President's Cabinet, no representation among the

ambassadors to the first courts of Europe, and only one of the assistant secretaries at Washington is of southern birth. The south took no constructive part in the four greatest political questions of the past decade. Two things must be done to reinstate this section in the privileges and burdens of American public life. First, we must build up that type of institution which will stimulate and train leaders; second, we must develop in our youth and in the people of other sections that tolerance of spirit which is fair and just to all sections of our common country, that an equality of opportunity for public service may be open to southern youth.

We must educate a larger group of white leaders who shall be saturated with such intellectual fairness as shall provide the negro a fair chance and shall relieve the public sentiment of the prevailing pessimism regarding negro education. And yet the white leader can never educate the colored race. The number of local leaders of the colored race must be immensely increased. The training given in higher institutions is not transmitted to the elementary schools for want of a group of middle leaders among the colored people. There are only 17 public high schools for negroes in the south.

The course of study in southern high schools should be directed toward the needs of social life. There are in the south 7,440,967 persons who are wage-earners, according to the last census. Only 187,443, or 2.7%, of this number are engaged in the professions. Yet our courses of study are planned primarily for professional men. Although the south is largely an agricultural section, yet there are no preparatory courses in agriculture in the high schools. As a consequence only 769 white students in agricultural colleges pursued such courses in 1903, although there were 5,341 in attendance upon such colleges. This illustration suggests the chasm which separates the colleges and universities from the lives of the people, which chasm will be bridged only by the perfection of a secondary school system.

Our Commercial Relations with Latin America: HAROLD BOLCE, Washington, D. C.

It is customary to speak in jubilant terms of our commercial destiny in Central and South America. Up to the present, America's share in the foreign commerce of the southern islands and republics of this hemisphere is insignificant. The latest figures show that the foreign trade of the countries (exclusive of South America) washed by the Caribbean amounts to $462,000,000. When to that sum is added the value of the external commerce of the Atlantic republics of South America, the total is found to exceed one billion dollars. Of this splendid trade, to reach which no canal is necessary, the United States gets a pitiable ten per cent.

Of that ten per cent. nearly one half consists of food-stuffs, lumber and kerosene, practically non-competitive products. As a people, we have made almost no effort to get the trade of Latin America. But for the presence of American colonies in Mexico and the West Indies, our south-

borne exports would be too paltry to enumerate in the totals of American prosperity. At the present rate of our shipments of merchandise to all lands between our border and Patagonia, it will require over one thousand years for the total value to equal the sum of the exchanges in 1905 in the clearing houses of the United States.

We look forward to sailing through the Panama Canal to a large commercial destiny. But we are ignoring a billion dollar commerce on the Atlantic side of the isthmus. We have the wide sea as a trade path to the markets of the West Indies, Central America and the eastern portion of South America. To reach these fields, we have no more need of a canal at Panama than of the Northwest Passage. By the time we conplete the Panama Canal, Japan may be the dominant commercial power of the Pacific. Even if the Chinese Empire were to remain friendly to America and the awakening of the whole orient be postponed until we are ready to travel through our waterway, the canal itself would not secure us the commerce of the far east any more than the Atlantic and Caribbean have secured us the trade of the eastern seaboard of Latin America.

JOHN FRANKLIN CROWELL,
Secretary.

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ADDRESS

BY

WILLIAM T. SEDGWICK,

VICE-PRESIDENT AND CHAIRMAN OF SECTION K FOR 1905.

THE EXPERIMENTAL METHOD IN SANITARY SCIENCE AND SANITARY ADMINISTRATION.

The value of experimentation in all branches of inquiry is now generally recognized; its philosophical significance and its limitations are less often understood and appreciated. In the present paper I propose to show that there is no hard-and-fast line between the results of experiment and those of experience, and that in the field of sanitation, in which of necessity laboratory experiment is difficult when not impossible, the data of experience carefully studied and rigidly verified are capable of yielding results no less valuable than those derived in some other subjects by experiment.

To avoid confusion let us understand clearly at the outset exactly what we mean by the terms *experiment*, *experience* and *observation*. The word *experiment* originally signifying much the same thing as experience, namely, both the process and the results of trial or test, has in recent times come to be used chiefly for a prearrangement, and an artificial arrangement, of conditions in such a way that specific questions shall be answered; while the term *experience* has come to be used most often to describe a result rather than a process—a result, moreover, obtained without prearrangement, and under natural or unpremeditated, rather than artificial or premeditated conditions. We speak, for example, of an *experiment* upon the strength of materials and an *experience* with a broken

rail or railway bridge. The term *observation* requires no special comment. Without this, both scientific experiments and scientific experience are impossible. *Verification* is, of course, the checking, controlling or testing of the data and results of experiments or experiences in order to determine their accuracy or degree of truth; and we are still indebted to George Henry Lewes for his striking exposition of the fundamental and indispensable function of verification in all sound and scientific inquiry.

Now a little reflection will show that experiment, in the somewhat narrow sense here laid down, is necessarily comparatively limited, and very likely to be confined largely to the laboratory, for the reason that any prearrangement of conditions which shall be actual tests or trials of natural phenomena must oftenest be made under cover, in limited space, with comparatively few objects, and at comparatively small cost. Hence it has come to pass that the experimental sciences have been chiefly those which could be advantageously pursued in laboratories and workshops, and upon the small, rather than the large scale. There can be little doubt that this fact has tended to magnify the importance of subjects or parts of subjects lending themselves readily to laboratory experimentation, and has served to draw off attention from, and thus to hinder, the development of other sciences, or portions of sciences, quite as important as those capable of advancement by laboratory experimentation. In physics, for example, we may well suspect that materials at hand, such as air or water, and problems at hand, such as the behavior of bodies at various moderate temperatures, have received more study than their intrinsic importance requires, while remoter objects such as the heavenly bodies, and very high and low temperatures, have not received the attention which they deserve. Doubtless the same fact holds in the biological sciences, including physiology and medicine. Experiments upon the physiological action of drugs have probably received, especially in the past, relatively too much attention, because of the ease with they could be carried out; while the more difficult and more costly experiments, for example, those required to determine the purity of large bodies of water such as rivers and lakes, or

those upon the purification of sewage, have until recently received but little attention.

There is danger, moreover, that in the instinctive recognition of the difficulties of laboratory experiments upon large and difficult problems, investigators shall turn aside from the careful study and verification of the data and results of another class of experiments which, for the sake of differentiation, we may call natural rather than artificial experiments, and which in everyday language are described as *experience*. It is, for example, obviously unwise to regret our inability to test by the methods or ordinary artificial experiment the effects of polluted drinking water upon large communities, when there are frequently being exhibited, all about us, by such communities, natural experiments on a grand scale; the conditions of which can often be accurately determined, even after the fact, and the results of which are as capable of verification as are those of artificial experiments prearranged to answer specific questions.

When, in 1893, the city of Lawrence, Mass.—long in the habit of drinking the unpurified water of the polluted Merrimac river, into which only nine miles above the intake of the Lawrence waterworks the raw sewage of the city of Lowell was poured—set up between that water and its citizens a barrier of defense (a sand filter) permeable by water but impermeable by disease germs, an experiment was undertaken under conditions quite as clear and as favorable as those under which many laboratory experiments are conducted. The data at hand concerning this experiment—concerning its cause, inception, conduct and consequences, were such as to enable those having the opportunity to study it to reach results, and to draw conclusions, of high accuracy, and even to predict with confidence the consequences of similar experiments elsewhere. This experience of a modern American municipality was also an experiment in the narrower sense—although not a laboratory experiment; for it was made artificially and by prearrangement, in order to solve a specific problem, namely, to get rid of typhoid fever in a community in which that disease had long been, in the old phraseology, "endemic."

One experiment often leads to another, and so also an experience often leads to an experiment. Years before, in 1872, acting under the best engineering and scientific advice of the time, the city of Lawrence had introduced for the benefit of its citizens a public water-supply drawn directly from the Merrimac river, nine miles below the mouths of the sewers of Lowell, as already stated above. In doing this there was no thought of making any scientific or sanitary experiment, but only of supplying the city with water for fire purposes and domestic convenience. Unwittingly, however, an important experiment was really being made by that municipality. As surely as if by premeditation and prearrangement a trial was being made, day by day, and year by year, of the effect upon the public health of the city of the use of a water-supply polluted with human excrements; and when, in 1890, typhoid fever appeared among the citizens to such an extent as to constitute a terrible epidemic, and to cause careful observation and study of the past as well as the present, it became evident that a most important experiment had been going on ever since 1872—quietly, naturally and unobserved—and an experiment not merely dire in its consequences, but rich in its sanitary teachings.

Careful studies of the various phases of this long-continued and tragically-ending experiment showed that the citizens of Lawrence had submitted themselves to and participated in conditions such as no premeditating experimenter in his wildest flights of fancy wouuld have dreamed of proposing; for they had, for twenty years, been drinking the diluted excrements and other wastes of a large and dirty city. Further studies revealed the fact that so long as these excrements were unmixed with those of typhoid fever patients no excess of typhoid fever ordinarily appeared in Lawrence, but that if typhoid fever abounded in Lowell then, after the lapse of a period of time such as would be required for its transmission to the citizens of Lawrence, and for its usual incubation, typhoid fever invariably appeared in the lower city. In the end, this unpremeditated experiment proved to be remarkably instructive, for while Lawrence and Lowell were thus unconsciously experimenting, Haverhill, on the same river a few miles below, and Nashua a few miles above, experimenting with relatively pure water supplies, suf-

fered no excess of typhoid fever. These facts threw great light upon the cause of a constant excess of typhoid fever long characteristic of Lowell, calmly accepted by the local physicians and sanitary officials as "endemic"—whatever that might mean—and regarded by them as unavoidable. For when the opportunity came to test their theory by a premeditated experiment, namely, the purification of the water, this "endemicity" of typhoid fever in Lawrence disappeared. It then became clear that the so-called "endemic" was really an epidemic condition; an epidemic condition characterized by the constant existence of a moderate number of cases, rather than the occasional existence of a great number, *i. e.*, by constancy, rather than magnitude.

These simple facts will serve quite as well as any more extended discussion to establish the fact which I desire especially to emphasize in this paper, namely, that the experimental method is not necessarily confined to laboratories, or applicable only to individuals. Some of its best examples, and some of its richest fruits, may be found in sanitation, as well as in physiology or hygiene; in the environment as well as in the individual.*

The practical importance of the recognition of these facts is very great. Comparatively few physicians or sanitarians are in a position to conduct artificial experiments of much importance, whether inside or outside the laboratory, but almost any wide-awake observer, whether he be physician, physiologist, sanitarian or engineer, may, if he will, find going on all about him natural experiments, the conditions of which may often be learned with great accuracy even after the experiment is completed, and which may yield conclusions quite as capable

*The author believes that a natural and serviceable distinction may be drawn between hygiene and sanitation, the former term being kept for those aspects of general hygiene, or the public health, affecting directly individuals or groups of individuals, the latter for those affecting directly their environments. He has used this distinction with advantage for some two or three years past in his teaching and in his writing, *e. g.*, in the *Encyclopedia Americana*, Vol. XIV., article "Sanitary Science and Public Health," New York, 1904, and in a paper, "The Readjustment of Education and Research in Hygiene and Sanitation," *American Medicine*, XI, 159–161, Feb. 3, 1906 and *Proceedings*, American Public Health Association, Boston Meeting, 1905

of verification as are those of experiments made in the laboratory. This should be a matter of no small encouragement, especially for younger workers who, wherever they are, and whatever they may be doing, may safely rest assured that if they will bring to bear upon the experiments which nature is making all about them the same careful observation, generalization and verification which they would apply to laboratory experiments, they are no less likely to reach results of the highest consequence, as well as to win the cordial appreciation of all discerning scientists.

Many communities, moreover, are nowadays embarking upon new phases of water supply, sewerage, and sewage-disposal, which, rightly considered, constitute veritable experiments in sanitary science and sanitary administration. And one of the most encouraging signs of the sanitary times is the custom, now universally approved and already widely adopted, of instituting elaborate and often extensive experiments before embarking upon costly and far-reaching improvements, the outcome of which would otherwise be doubtful or uncertain. The establishment by the State Board of Health of Massachusetts in 1886 of a sanitary research laboratory and water and sewage experiment station, on the shore of the Merrimac river, in Lawrence, marked the beginning of a new and important era in practical sanitation, because it was the introduction of the experimental method into a field of human activity in which hitherto the results of natural experiments had been the only guide. Imbued with the scientific spirit, and convinced of the importance of the experimental method in sanitary science, as demonstrated at the Lawrence Experiment Station, where they were among the earliest workers, Messrs Allen Hazen and George W. Fuller, now sanitary engineers of the first rank, caused the same methods to be invoked and applied before embarking upon the purification of the water supplies of Pittsburg, Albany, Louisville, Cincinnati and other cities, with which they have had to deal. Still more recently, Mr. Fuller has planned and conducted, at an expense of $50,000 or more, a series of elaborate experiments in order to determine the best methods for the purification of the sewage of the city of Columbus, Ohio. The results of all these experiments are everywhere

conceded to have been so valuable and instructive that well-advised municipalities to-day rightly hesitate to embark upon large and costly schemes of sanitation without first having made extensive experiments, locally conducted, bearing upon the solution of their own peculiar problems. It has been learned, meantime, by both experiment and experience, that the terms "water" and "sewage" which have so long been used in the abstract in sanitary science, when applied to concrete natural waters, and municipal or manufacturing wastes, ought rather to be made plural, for the reason that the waters of various parts of the country, and the sewages of different communities, differ so widely one from another, as to require very different methods for their successful treatment.

In other forms of sanitary practice also, such as the drainage of marshes, the petrolizing of ponds or stocking them with fish, the experimental method has been usefully employed. Experiments upon the improvement of cows and cow-stables have given good results in cleaner and more normal milk. Experiments in street cleaning have shown that dirty streets are an evil, but not a necessary evil. Experiments in the separation and utilization of wastes have yielded results of sanitary and financial importance. Experiments like that of the city of Munich on the effect of sewerage upon the public health; experiments upon the cost and importance of systems of heating and ventilation; experiments upon the efficiency of copper sulphate as an algicide; experiments on the influence of pasteurized milk upon infant mortality—all these, and many more that might be given, testify to the value of the experimental method in sanitation. And yet, in most cases of this kind, we have to say, as Adams said of political experiments, "these can not be made in a laboratory or determined in a few hours."

There remains however, one department of sanitation, viz., that of sanitary administration, in which the results of experience are more abundant than those of experimentation, results, too, which can not be regarded with either pride or satisfaction. I refer to the constitution and sanitary work of our various state and local boards of health. In some few cases these boards are well constituted, courageous, intelligent and efficient. In a few cases they are even famous for their good work. In some

other cases, although themselves incompetent, boards of health have had the good sense or good fortune to employ as their agents real experts, and to delegate to these their sanitary work. But experience shows that some state boards, and many local boards of health in the United States, are badly constituted, inefficient if not ignorant, and cowardly. The experiment has now been fully tried of appointing to such boards mere place-seekers or incompetents, with the natural results of poor public service and dangerous neglect of the sanitary interests of the people. It requires some knowledge, skill, courage and wisdom to administer the sanitary affairs of a modern community, and few indeed are the American cities or towns which have made the experiment of organizing their boards or commissions of health to meet these requirements. Too often a hack politician or two, a second rate-doctor or two, and one or more vain or place-seeking nobodies—useless but not harmless—make up our local boards of health; and as no stream can rise higher than its source the services of such boards are disgracefully small in quantity and poor in quality. It requires no further use of the experimental method to predict from such direction or control of sanitary affairs, in further trials, dismal failures.

Worst of all, this foolish and almost criminal experimenting is going on while we have to-day in America opportunities for some of the most interesting sanitary experiments that any scientists could desire. We are establishing model dairies, model municipal water filters, model sewage and garbage disposal-plants. Why can we not also experiment with a few model boards of health, which shall boldly set to work, and themselves make the experiment of trying to give to the city or town under their care the best possible sanitary (and I may add, hygienic) conditions? Why can we not have more boards constituted, like that of Montclair, N. J., of one or more leading physicians, one or more good civil engineers, one or more good lawyers or business men? Why can we not have more boards experimenting upon the control of milk supplies, as are to-day the boards of Montclair, of New York and of Boston? More boards studying experimentally the conditions required to secure proper heating and ventilation of public halls and

public conveyances? More boards experimenting upon the suppression of the smoke nuisance, the dust nuisance, the noise nuisance? It is of comparatively little use to make good laws if no one will enforce or obey them, and improved methods of sanitation (and hygiene) are of small value unless intelligent, courageous and energetic boards of health adopt and enforce them.

In Massachusetts the district medical examiner has displaced with great advantage to all concerned, the aforetime local coroner. And if, as there is much reason to suspect, local influences and prejudices make it almost everywhere difficult to secure able and aggressive local boards of health, then the experiment should be tried of having district, county or state officials, authorized and willing to do the necessary sanitary work. The present plan is a failure experimentally demonstrated; let us continue to invoke the experimental method in which we believe, but abandoning our present custom which has been experimentally proved—for the thousandth time—to be hopeless, let us try something more promising. We can not do much worse; we ought to do much better.

REPORT OF THE SECRETARY OF SECTION K.

SCIENTIFIC PROCEEDINGS.

Morning Session.

Vice-presidential Address—The *Experimental Method in Sanitary Science and Sanitary Administration:* WILLIAM T. SEDGEWICK.

Symposium on Yellow Fever and other Insect-borne Diseases.

Introductory remarks by the acting chairman, Alexander C. Abbott

GARY N. CALKINS: "The Protozoan Life Cycle."

HENRY B. WARD: "Filariasis and Trypanosome Diseases."

J. H. WHITE: "The Practical Results of Reed's Findings on Yellow Fever Transmission."

Afternoon Session.

QUITMAN KOHNKE: "Difficulties of Recognition and Prevention of Yellow Fever."

HENRY CLAY WEEKS: "The Practical Side of Mosquito Extermination." (Presented by A. C. Eustis.)

JAMES CARROLL: "Without Mosquitoes there can be no Yellow Fever."

H. A. VEAZIE: "Æstivo-autumnal Fever—Cause, Diagnosis, Treatment and Destruction of Mosquitoes which spread the Disease."

Discussions of the various papers at each session by Messrs. James Carroll, G. N. Calkins, L. O. Howard, J. H. White, S. E. Chaillé, A. C. Abbott, A. L. Metz, H. B. Ward, Quitman Kohnke, A. C. Eustis and others.

SYMPOSIUM ON YELLOW FEVER AND OTHER INSECT BORNE DISEASES.

The Protozoan Life-Cycle: GARY N. CALKINS.

The wonderfully successful results obtained in New Orleans in the struggle against *Stegomyia fasciata* has shown that in yellow fever, as was long the case in smallpox, protective measures may be understood and applied, although the specific cause of the disease is unknown.

I do not intend to discuss the question as to whether this specific cause is a bacillus or a protozoon, nor to consider the various organisms that have been found in infected yellow-fever mosquitoes. I purpose, rather, to speak upon some of the general biological phenomena distinctive of protozoa, and of the variations in vitality at different periods of the life-

cycle, and then to point out in how far the present data regarding the yellow-fever organism agree with these established facts.

The protozoa are minute animals, consisting for the most part of single cells having an independent life. They vary in size from minute forms, too small to be seen with the highest powers of our modern miscroscopes, to giant forms from two to three inches in diameter. The vast majority thrive in seas and lakes, stagnant pools and ditches, and are absolutely harmless to man; indeed, they become a boon to him by giving to thousands of microscopists the materials for a fascinating pastime. A small minority are parasitic, but these few cause vast epidemics among silkworms, fish and domestic animals, and have been the means of great economic loss, or through malignant epidemics, have terrorized whole communities and have brought about untold loss of life.

A protozoon rarely retains its individuality more than a few hours. It then divides into two, or in some cases, into a larger number of daughter individuals. The parent organism has not died, there is no unicellular corpse, but the protoplasm of which that organism was composed is now distributed by division among two or more individuals. The process is repeated again and again, and thus it continues, a repetition of growth and reproduction. We cannot speak, therefore, of the life-cycle of an individual protozoon, but must consider rather the protoplasm of which that individual is composed. It is this protoplasm that goes on through generation after generation of individuals, and through all the phrases that constitute the aggregate of phenomena which has been termed the life-cycle.

It was formerly believed that this protoplasm, having all of the necessary functions required for an indefinitely continued existence, gives to the protozoon the attribute of an endless life—physical immortality. Experiments made within comparatively recent times have shown, however, that this is not true and that the protoplasm of a given protozoon gradually loses its vitality with continued division or asexual reproduction until it ultimately dies of old age no less surely than does the protoplasm that makes up the tissues and organs of higher animals. It is known that a protozoon immediately after conjugation with another of its own kind, a process which agrees in essentials with the fertilization of an egg by a spermatozoon, has a high potential of vitality which enables it to live and multiply asexually for a long period, with, however, a gradually decreasing vitality which, unless renewed by conjugation, ultimately gives out, the protoplasm dying of old age. Conjugation, then, appears to be a process of rejuvenescence and has been so interpreted since the classical experiments of Maupas in 1888 and 1889.

In every protozoan life-cycle, in free living and parasitic forms, we can make out, with more or less precision, three phases which correspond with analagous phases in the life of a metazoon. The vigorous, actively dividing forms are found in the period immediately after conjugation and this period corresponds with the period of youth. The conjugating period,

or the time when the protoplasm is capable of renewing its vitality by conjugation, corresponds with the period of adolescence, or maturity, and, in the forms which have not conjugated, the period of increasing degeneration and old age compares with the old age of metazoa.

The study of many types of protozoa has shown that with decreasing vitality there are frequently marked changes in the form of the body and in the physical composition of the protoplasm. These changes are most marked at the period of sexual maturity, when they frequently give rise to structural modifications as widely different as the egg and the spermatozoon. It is while in this condition of the protoplasm that sexual union takes place and, through this, renewal of vitality and return to the type form. This condition of the protoplasm, which indicates a modification of the physical organization of the protozoa at periods of adolescence, comes sooner or later in the history of any life-cycle, but it can also be induced artificially in many cases. Thus it has been possible to change ordinary asexual flagellated protozoa into sexual forms by increasing the density of the surrounding medium through addition of sugar, etc.; or by lowering the temperature, perhaps again, a matter of density. In a number of parasitic forms, some of which affect the welfare of human beings, a similar change in environment is a normal part of the life-cycle, and is brought about by insects, sometimes mosquitoes, sometimes ticks and sometimes flies, The sexual protozoon organisms are transferred from the warm blood of birds or mammals, or man, to the cold environment of the insects' digestive tract. This is accomplished in the case of malaria by mosquitoes belonging to the genus *Anopheles;* in the case of bird malaria by mosquitoes belonging to the genus *Culex;* in the case of sleeping sickness by the tsetse-fly; in the case of Texas fever among cattle by ticks belonging to the genus *Boophilus*. Where the full life history has been made out, it has been found that conjugation takes place within the body of the insect and here, therefore, vitality of the parasite is restored.

What is known to take place in some of these well-authenticated cases is presumably true in the case of yellow fever. The blood with the organisms in it is taken into the digestive tract of the mosquito (*Stegomyia fasciata*), and here, or in some other organ, the germ probably passes through some developmental cycle, for a period of twelve days is necessary before such infected mosquitoes can transmit the disease to another human being. The similarity to the malaria organisms in the period of incubation, as well as in the change of hosts, is a striking argument in favor of the protozoan nature of the yellow-fever germ.

The different forms which protozoa assume at various periods of the life-cycle have been frequently mistaken for different species or different genera, and well-known cases such as *Plasmodium* and *Polymitus*, or *Coccidium* and *Eimeria*, where the different phases were regarded for a long time as distinct types of organisms, justify the view that the entire life-cycle should be taken into consideration when describing species. The changes in form at the different periods are due, as I believe, to the differences in vitality.

[Here a number of lanterns slides were shown Illustrating the variations in structure, etc., in various types of protozoa.]

In *Tetramitus* the free-living asexual forms have a definite membrane and a definite body form and continue to multiply by simple division for a period of two or three days, when the definite membrane becomes plastic and the body assumes more or less amœboid forms resembling the genus *Mastigamœba*. In this condition of the protoplasm two individuals upon coming together fuse into a common mass, their nuclei unite and conjugation is effected. After conjugation a firm cyst is secreted within which the protoplasm divides into hundreds of parts, which escape from the cyst, finally, as young flagellates.

In *Polystomella* the polymorphism is shown by two types of shell and by different forms of the young organisms. In the microsphæric type there is a characteristic fragmentation of the nuclei into many chromatin particles of small size. This is followed by formation of amœboid spores, which develop into shelled forms of a different type from the first (macrosphæric), and these in turn give rise to flagellated spores which conjugate.

The decrease in vitality can be measured in a rough way and the relative vitality at different periods can be easily compared. This has been done in the case of some of the free living infusoria, for example in *Paramœcium*, *Oxytricha*, etc. For such comparisons a single individual is isolated and within twenty-four hours it divides. The daughter cells are similarly isolated, and this process is repeated until the protoplasm under observation dies from exhaustion of vitality, in one case (*Paramœcium*) after twenty-three months of observation, during which time 742 divisions were recorded. When averaged for ten-day periods these divisions gave a satisfactory measure of the vitality at different times during the cycle. It was found in these experiments on *Paramœcium* that after about 200 generations the vitality is apparently exhausted, but that it can be restored by artificial means and stimulated to a new cycle of about 200 generations. Ultimately, however, artificial stimuli failed to renew the vitality and the race died out in the 742d generation. Such artificial stimulation suggests the possibility that in certain human diseases, such as malaria, the organisms may become exhausted so far as the division energy is concerned, but may remain quiescent in the system, hibernating, as it were, in some organ until, owing to some change in the chemical composition of the blood, an artificial stimulus renews the division energy and a recurrence follows.

Turning now to the data that have accumulated in regard to the organism of yellow fever, we must note that the rapid development in the blood indicates a high potential of vitality; that the disappearance from the blood indicates that the organisms have been killed off through excess of their own toxins, or by accumulation and action of the anti-bodies. The long period of incubation in the mosquito indicates that processes are taking place in the development of the germ which can be explained only on the supposition that conjugation phenomena, analogous to those in

the malaria mosquito, are taking place, and this supports the view that in the human blood the organisms are endowed with a high potential of vitality. Again, the filtration experiments in which it has been demonstrated that the organisms may pass through the finest filters known to us, indicate that the organism is among the smallest of living things, and belongs to that group which is rapidly becoming more than hypothetical, the ultra-microscopic forms. The small size may be a result of rapid multiplication, and it is not improbable that after the incubation period larger forms will be recognized in the digestive tract of the mosquito and in the salivary glands.

Finally, if the organism is a protozoon there is only a limited possibility as to its systematic position. Larger forms like *Trypanosoma* would not pass the finest filters; corpuscular parasites like *Piroplasma* would likewise be filtered out, besides which the yellow fever organism is known to be a plasma parasite. A single genus of protozoa is known at the present time that fulfills all of the conditions of the yellow-fever organism; amongst its species are some that are at times ultra-microscopic; that have a characteristic change of hosts from warm-blooded forms to mosquitoes and that are characterized by remarkable virulence. This is the genus *Spirochæta* and in it alone, at the present time, do we find the type that satisfies all of the conditions known of the organism of yellow fever.

Dr. James Carroll said in discussing Professor Calkin's paper: "I have listened with the greatest interest to Professor Calkins's exposition of the life histories of protozoa and I am reminded by it of a series of hypothetical experiments that for some time I have felt a great desire to see performed and which might throw a flood of light on the nature of the parasite of yellow fever. Reasoning from the standpoint that the organism is an obligate animal parasite, a series of passages through the human being by means of direct inoculations with blood, without the intervention of the mosquito, should gradually bring about attenuation or eventually render it incapable of further reproduction in man, by restricting its existence to a single phase of its life-cycle. Such a result would almost conclusively indicate the kingdom to which it belongs, but the deterring factor is, of course, the risk to human life."

Filariasis and Trypanosome Diseases: HENRY B. WARD.

The presence of microscopic nematodes in the blood was recognized as early as 1872, though their separation into distinct species has not even yet been fully accomplished. The best known of these embryonic forms is that belonging to *Filaria bancrofti*; it was shown by Manson to manifest definite periodicity in its occurrence in the peripheral circulation, and hence was designated *Filaria nocturna*. During the day this form retires to the capillaries of the lungs. For further development it must be taken

up into the stomach of a mosquito, from which it wanders out actively into the thoracic muscles and there assumes a quiescent stage. There appears to be no definite generic adaptation as in the case of the malarial and yellow fever organisms, but various species of *Culex* and *Anopheles* may serve as intermediate hosts. After a period of rest and growth covering fourteen to twenty days the larvæ become migrants and move through the lucanæ of the body into the proboscis. The precise method of transference into a new host is not yet clearly demonstrated, but the filariæ are next found as adults coiled in lymph glands. The enormous mass of embyros produced by the females blockade locally the lymph vessels and the resulting lymph stasis leads mechanically to dilatation of the tissues and increase in the size of parts which shows itself as varicose glands, chyluria, or elephantiasis. After brief reference to other species which are only insufficiently known, reference was made to the occurrence of these forms in the western hemisphere and to their presence also in various parts of the United States. The author emphasized the need of careful studies on the anatomy of both adult and larva to enable the diagnosis of various species, and on the life history and transmitting agents to explain the spread of the parasite and the means of prevention. Attention was also called to the relations of these forms to various domestic and wild animals as facultative hosts and possible means therein of the multiplication and spread of species, while the advisability of search for the embryo forms in the blood and the need of more detailed and accurate knowledge of the pathological changes induced in the human body were noted.

After brief consideration of the morphology of the *Trypanosomes* their occurrence in a pathogenic rôle was discussed for the nagana, tsetse-fly, disease of Africa, the surra of India, China and the east, the dourine of horses in the Circum-Mediterranean region, and the mal de caderas among horses on the pampas of South America. Dutton in 1901 discovered a related species in the blood of a European who had been resident on the Gambia river in Africa, and the relative frequency of such cases together with their distribution over the territory bordering on the Gambia and Congo was noted. The same form was discovered by Castellani in 1903 in the cerebro-spinal fluid of negroes suffering from "sleeping sickness" and gave the key to the etiology of that disease. The life history of these forms has not yet been elucidated unless the recent work of the Koch expedition to Africa has succeeded in solving it. It is reasonably clear, however, that these organisms pass through one phase in the life-cycle in the body of some transmitting agent, which is probably a blood-sucking Insect. The discovery by MacNeal and Novy of a method by which such forms may be cultivated in the laboratory, marks a great advance and has been successfully used to detect the presence of forms not demonstrable in preparations of the blood itself. It has not availed as yet to furnish any method of treatment for the diseases produced by the organism. The phase represented in such cultures is undoubtedly only

the asexual. A brief discussion followed of related forms, such as the *Spirochæta* of the owl studied by Schaudinn, of the species present in syphilitic lesions and of the Leishmann-Donovan bodies; and the importance which these observations have, though incomplete, was pointed out in indicating the life history and pathological significance of the group. The author also indicated the necessity of study to determine the intermediate hosts which subserve various parasites, to secure more perfect knowledge of normal blood, and emphasized the value of more general and precise examinations of the excreta and body fluids which would be likely to disclose the presence of other organisms of this type as yet unsuspected.

The Practical Results of Reed's Findings on Yellow Fever Transmission: J. H. WHITE.

For the first time since Reed, Lazear and Carroll did their great work in Cuba, the opportunity offered, in 1905, in the city of New Orleans, to demonstrate on a scale of such magnitude as must needs be impressive, the true value of that work.

I have no desire to underrate the work done in Havana. It was a noble accomplishment, and one that should immortalize its doers, but we must remember that the Cuban city had a population ninety-five per cent. of whom were immune, and was built upon high and dry ground, while the population of New Orleans was at least seventy-five per cent. non-immune, the city itself being a perfectly natural habitat for the mosquito.

The fight began in Havana in the early spring, against two or three cases. It began in New Orleans under the blazing sun of late July, and against hundreds of cases.

There were two distinct organizations in the city of New Orleans, each one having the same object in view and working in cooperation with each other. The Citizens' Volunteer Ward Organizations sought to destroy all mosquitoes by the screening and oiling of cisterns, by the oiling of gutters and pools, and a desultory sulphurization of houses. This last they could only accomplish by pleading with the people to do it, and nothing like perfection in this line was ever attained at any time, the *laissez faire* of the attitude of the people in general upon this question being too well known to need comment.

The regular organization consisted of a central headquarters, with at first sixteen, and subsequently eighteen ward headquarters, corresponding, practically, with the political geography of the city. Each of these subheadquarters was in command of a medical officer, provided with from one to six medical assistants, according to the needs of his station, and kept in touch with the central office through the medium of an officer who served as adjutant. Each subdivision had its own gangs of inspectors, screeners and fumigators, and was furnished with all necessary supplies from a purveying depot established for that purpose.

Upon the report of a case of fever, either suspicious or yellow, to the

city board of health, the central headquarters or the ward headquarters, the information was immediately conveyed to the commanding officer of the ward concerned, and a screening gang at once started for the house, placing screens and, if need be, mosquito bars around the patient, who, if his condition permitted it, was moved into another room, his own room fumigated and he then returned thereto, the rest of the house being at once fumigated. All cracks were pasted over from the inside and all chimneys attended to at the earliest possible moment in order to prevent their becoming the hiding-place of the infected *Stegomyia*. Before the expiration of twelve days, a second fumigation was resorted to in order to be sure that no infected mosquitoes escaped.

Our work with its results fully justifies the assertion made by Dr. Carroll that the best policy is to treat all cases of fever as worthy of suspicion. There is no doubt that during this fight there were thousands of unnecessary disinfections done, but it was just as necessary as any other part of the work, as long as no man can always be relied upon to make an exact diagnosis in any disease, the causative entity of which is not definitely known, hence we did not wait for definite diagnosis, but disinfected first and secured the diagnosis when we could.

Of course any sick persons willing to go there were removed to the emergency hospital provided for the purpose, and so carefully screened and safeguarded against mosquitoes in every way as to render the use of mosquito bars unnecessary.

In the original infected area house-to-house inspection, and, indeed, house-to-house disinfection, were kept up continuously from the latter part of July until about the first of October. All over the city house-to-house inspections were made to some extent, and this work was largely instrumental in forcing the report of cases which, otherwise, might never have been reported and might have served as seed for a future distribution of the disease.

With a view to the general elimination of the mosquito, we salted 750 miles of street gutters, using some 3,000,000 pounds of rock salt to form a minimum solution of five per cent., and in so doing incidentally cut the malaria rate down to almost *nil*.

One of the most serious problems of yellow fever has ever been, and was this year, that of transportation. In order to satisfy public clamor, we disinfected cars, both passenger and freight. We relayed passenger coaches and cut out Pullman traffic, so far as direct entry into the city was concerned.

I am strongly of the opinion that most of this car disinfection and relaying was unnecessary, and in support of that view I wish to call attention to the fact that, having an abiding faith in the ideas which I shall hereafter state, I purposely omitted any relay or disinfection of the Louisville & Nashville coaches out of New Orleans, going to the Alabama state line, where they were relayed. These coaches went from the city of New Orleans, traversing the entire width of eastern Louisiana and southern

Mississippi, a distance of 116 miles every day and every night, without any precautions whatever being taken until some weeks after the beginning of the outbreak, and then the windows were screened.

These cars were boarded by Mississippi National Guardsmen who served as quarantine guards, and who traveled *in the cars* with the passengers, from the western to the eastern border of the state of Mississippi and back again, day and night, in dry and in humid weather, for the whole period during which yellow fever existed in New Orleans. There were some score of them so exposed to any infection which might have existed in these coaches, but not a single one of those men so acting as train inspectors, nor any of the train crews, was taken sick with any kind of fever whatsoever, and I wish, in concluding this particular portion of my remarks, to accentuate the fact that these coaches traveled up and down Elysian Fields street in the city of New Orleans, on both sides of which street the infection was rampant, as well as up and down the river front of the city, passing the original infected area where the infection was most prevalent; thus determining, at least to my mind, as strongly as circumstantial evidence may determine anything, that the infected *Stegomyia* does not travel to any noticeable degree; that *she remains*, as nearly as she may, at the place *where she first tastes blood*, and will not voluntarily leave a house, much less cross a street.

The case in which she can not find food, water and seclusion in the habitat she chooses at her birth is rare indeed, and finding these, she needs no more.

She can not abide the glare of a midday sun, as shown by Berry, of the Public Health and Marine Hospital Service, who found this species killed by two minutes' exposure to a noon sun, in Texas, in 1903.

We must not attempt to reason from analogy with other species, and be led into error because others do travel. The *Stegomyia* is a domesticated species and may be justly likened to the quiet German peasant, while the *Culex solicitans*, like a wandering Bedouin, rises from her native marsh and willingly drifts with the wind. Unlike the *Stegomyia*, she has no home and wants none. She is not choice as to her meal of blood—any old hide will answer the purpose.

The rarity with which the *Stegomyia* migrates has been indicated many times by the frequency with which houses so close to the infected dwelling as to be almost contiguous, have escaped infection. It is further illustrated along the same lines as those I have already mentioned in regard to railroad cars, by the fact that in each case in which we have been able to trace the manner of infection in a city or town, it has been found that the locality was infected by some person who, arriving there during the incubative period of the disease, subsequently developed the fever. In no instance has there been any legitimate evidence which would point to any other method of infection.

I believe the idea prevailing among some people with regard to the traveling of the infected mosquito to be a bugaboo, though I do not desire

to be understood as saying that the *Stegomyia* never does travel. It unquestionably does, but only because in the incipiency of its life it has taken up its habitat in a car instead of a house, or because accidentally imprisoned in a box or a drawer, it is carried, *nolens volens*, but rare, indeed, are such cases.

I have been quoted by Dr. Rosenau, in his work on disinfection and disinfectants, as saying that "disease more often crosses the street in a pair of shoes than in any other way." It was to yellow fever that I alluded in our conversation about this in 1898.

So confident were we of the absolute truth of the mosquito law, that right from the beginning we brought yellow fever patients from points outside of the city, and placed them in the hospital here, believing that in so doing we ran no risk of increasing the infection. We allowed people from infected points in the state, such as Patterson and Tallulah, and from the infected localities of Mississippi, to come into this city with no other precaution than that they should be provided with a certificate that they were not from an actually infected house and were in good health when they started. We had no trouble whatever on this score, and to the credit of American manhood and womanhood be it said, the addresses given by these people as their intended residences in the city were absolutely and invariably correct, and all of them were inspected without difficulty during the first six days of their sojourn here. The only trouble we had from incoming persons was occasioned by those who sneaked in from contiguous localities, and consequently evaded the daily inspection, as they had already ignored the requirement that none who came from an actually infected house should be admitted.

Yellow fever is so easy of control, if only the medical profession and the people will be frank and honest with the health officers, that it seems a crime against humanity that we must needs quarantine such a disease. There is no more rationalism in quarantining yellow fever than there would there be in quarantining typhoid. Indeed, there is less, because it may be stated as an absolute and invariable law, that a case of yellow fever known in the first two or three days of its existence, and to which proper measures can be applied, presents absolutely no menace to the community, nor even to the family resident in the house with it. Until, however, such laws are enacted and enforced as will make the concealment of a case of yellow fever, either through the complaisance of the family physician or the cowardice of the family, a crime and an absolute impossibility, there will continue to be more or less of quarantine—probably more. Such laws are deemed by many people an interference with individual liberty and incompatible with the rights of American citizenship, and similar buncombe, *ad libitum*. The only other alternative, and a most excellent one, too, will be the passage and enforcement of laws insuring the proper sanitation of our cities, this being a matter which offers so many other advantages in addition to the removal of yellow fever, as to make it appear to my mind the most imperative need that confronts the south as a whole, and the really proper solution of the entire matter.

It would be a false claim, if set up by any of our great northern cities, that they intelligently got rid of yellow fever, for it is a fact which must be apparent to all of us, that they did nothing of the kind. They intelligently provided themselves with municipal utilities which appealed strongly to their ideas of creature comfort and general cleanliness, and which, incidentally and entirely accidentally, eliminated the mosquito at the same time. These public utilities were a thoroughly controlled water supply, sewerage, drainage and pavements, and these four, not one, but all of them, were essential to the end attained.

We may rid the city of New Orleans of yellow fever, but we shall never rid it of its susceptibility to that disease until these four requirements are complied with, and the possession of these public utilities will also do away with many of the other "ills that flesh is heir to."

It is irrational to go on, year after year, fighting only the infected mosquito, when we can, with a little more trouble, destroy all mosquitoes once and for all. To put the matter plainly to the business man who is, after all, the court of last resort, make an investment now in good health, and it will pay you enormous dividends in increased business, in reduced loss of time by yourself and your employees, and in that priceless boon that comes only to the man free from any taint of disease—the one only thing that makes our north superior to our south—the pure joy of living.

I would briefly summarize the matter thus:

1. The only true way to fight yellow fever is to wipe out all mosquitoes by water supply, sewerage, drainage and paving.

2. As a palliative measure of temporary expedient pending the first proposition:

(*a*) Compel the report of all fevers.

(*b*) Screen all fever patients.

(*c*) Use a culicidal agent in all dwellings of the sick, at once, and again before twelve days have elapsed since patient sickened.

(*d*) Authorize inspection by health officer of any patient.

Though perhaps out of place, let me pay a well-deserved tribute to the patriotism of the citizens as a whole, and to the citizens' committee, the clergy and the medical profession, and finally, to that gallant band of officers, some sixty in all, who worked in the dust and sweat of August with untiring zeal, and particularly the score who were my captains and did such duty as, had it been rendered to the first Napoleon, would have been rewarded by a marshal's baton.

Difficulties of Recognition and Prevention of Yellow Fever: QUITMAN KOHNKE.

The doctrine of the mosquito conveyance of yellow fever, for the practical application of preventive measures based thereon, may be expressed thus:

The immediate causative factor, the germ of the disease, is accessible to the only natural vehicle of infection, the mosquito, during the first three days of the fever, and the germ after entering the mosquito's stomach requires twelve days to reach one of the salivary glands, from which the insect, while feeding, may inject it into the blood stream of its victim, in whose system the period of incubation is usually from three to five days, rarely six.

The human subject of the disease may be considered infectious, therefore, to the mosquito during the first three days of the fever, and not thereafter; the mosquito being infectious after the twelfth day from the date of inoculation, and not before. Its victim shows the first symptom of disease usually in less than five days after infection by the insect.

The exceptions to this rule are not sufficient to suggest its modification, but in actual practice the patient is considered possibly infectious during four days, and the mosquito possibly dangerous on the tenth day.

A case of yellow fever can not occasion another case in less time than the period of incubation in the mosquito, which is twelve days, added to the period of incubation in its human victim, which is not less than three; fifteen days completing the minimum cycle of infection. We may say approximately that explosions of infection should be expected, and are observable semi-monthly, and the result of disinfection can not be determined earlier than fifteen days thereafter. We can not say how many cases may result in about two weeks from one case untreated sanitarily, but we can say positively that no case will result if there are no mosquitoes present of the *Stegomyia* variety. Conversely we may apprehend a great infection in the presence of great numbers of mosquitoes.

The application of the mosquito doctrine to the prevention of yellow fever is all that need be done in any emergency, but to accomplish this is a problem not to be solved by any set formula. It is an easy matter to set down on paper and in an office a lot of rules in the abstract to be carried out in the field, but it is a different matter to apply these rules concretely to actual cases to obtain results.

Circumstances and conditions met with in actual practice may radically change the relative value of details esteemed of paramount importance theoretically.

As applicable to a locality or community, I wish to place before you three propositions, upon the first two of which is based the third, which is offered in the nature of a conclusion.

1. Quarantine against yellow fever can not be made absolute in its protective value.

2. Early recognition of the presence of yellow-fever infection is difficult always, and at times impossible.

3. The most dependable measure of prevention of yellow fever is destruction of the *Stegomyia fasciata* before the possibility of infection.

Extensive argument is not necessary in an assembly of this kind whose

every member is qualified to do his own thinking and form his own conclusions upon the evidence presented.

Quarantine.—In quarantine against yellow fever two essentials are to be considered, and nothing else. Detention of persons exposed to infection for not less than the period of incubation of the disease, and the prevention of entrance of infected mosquitoes.

The increasing rapidity and facility of travel makes quarantine more difficult and less reliable. However near to perfection may be our own maritime quarantine system, we shall always be exposed to infection by rapid land transportation from ports not themselves infectible, or which are less careful for other reasons. Quarantine, though important and necessary, can not ever be all-sufficient.

Early Recognition.—Early recognition of yellow fever, so essential to the prompt application of sanitary remedial measures, is rarely to be expected. The history in this respect of 1897-8 and 1899, as well as that of 1905 exemplifies this, not only in New Orleans, but elsewhere, even in Havana, where better preparation is made and better opportunities offer for the prompt discovery of early cases.

We should not relax our constant watchfulness during the season of danger, but we must realize that knowledge of the existence of first cases requires a combination of factors not always obtainable and not within our practical control,.

Destruction of Stegomyia.—Finally, we must, I think, conclude that the destruction of the only natural trasmitting medium is the surest preventive of yellow fever. This measure also is subject, of course, to imperfect application in practice, and incomplete results. It is not sufficient, alone, to guarantee against infection, but it offers the important element of time during which to encourage its thorough application; and in the event of the failure of quarantine and of the prompt recognition of infection, the spread of the disease is modified by even a partial destruction of the conveying medium, and this gives time for perfecting organization against the infected insects.

The health authorities of this city were convinced of the truth and importance of the mosquito doctrine of yellow-fever conveyance upon its first announcement, and of the importance of mosquito destruction

Twice a law such as is now operative was proposed and rejected, and our belief is now, as it was then, that the destruction of *Stegomyia* mosquitoes prior to the introduction of yellow fever is the ounce of prevention that is better than the pound of cure.

I show three charts of mortality for three separate years, one of which, 1905, is a yellow-fever year.

The causes of death are those under which yellow fever may be concealed, intentionally or not.

A careful analysis of these records does not bear out the notion, expressed by some, that yellow fever should have been recognized earlier than the middle of July through an inspection of the mortality from these causes.

1905.

	Malaria.	Acute Nephritis.	Bright's Disease.	Enteritis Under Two Years.	Deaths Typhoid.	Cases Typhoid.
January	0	6	60	11	11	32
February	4	3	51	10	2	7
March	2	7	42	7	8	16
April	3	3	35	25	6	26
May	5	8	48	116	6	19
June	5	4	44	91	11	24
July	11	6	32	38	28	114
August	6	5	43	18	13	31
September	2	4	27	24	5	26
October	2	5	34	11	3	12
November	5	8	44	14	6	16

1904.

	Malaria.	Acute Nephritis.	Bright's Disease.	Enteritis Under Two Years.	Deaths Typhoid.	Cases Typhoid.
January	4	5	38	9	9	16
February	3	5	40	3	7	15
March	5	8	41	16	2	8
April	4	7	37	80	6	18
May	6	3	32	70	10	28
June	5	4	42	50	13	28
July	4	5	42	40	11	45
August	6	6	25	22	14	58
September	13	5	32	19	12	37
October	9	10	47	17	10	26
November	6	8	42	16	10	26
December	3	5	56	12	7	31

1903.

	Malaria.	Acute Nephritis.	Bright's Disease.	Enteritis Under Two Years.	Deaths Typhoid.	Cases Typhoid.
January	3	4	53	13	5	16
February	1	7	53	12	4	8
March	4	2	53	10	6	13
April	2	5	39	20	6	13
May	9	5	41	82	8	28
June	11	5	30	73	18	55
July	10	3	39	56	16	59
August	9	3	51	26	21	79
September	8	3	54	11	14	66
October	11	7	51	17	8	25
November	10	6	49	18	2	24
December	3	5	50	17	11	26

The value of mortality charts is historic, not prophetic, in respect to yellow fever.

Investigation of individual cases, whose circumstances, together with the given causes of death, excite suspicion, is more reliable than an observance of increase in numbers and is earlier available. This is our routine summer practice during the danger period, and was done during the past summer with negative results.

The explosion of infection in New Orleans this year was due to an unfortunate combination of unfavorable conditions, to which was applied the spark of introduced infection. How the fever entered the city is not the official concern of the health officer, who has no function or authority in maritime on inland quarantine. When it got here, however, it found ideal factors for its development and spread. The section of the city first infected is the most densely populated, the people are for the most part ignorant of our language and illiterate in their own. Their habits are unsanitary and their customs such as tend to secretiveness and improvidence. They are not as a rule vicious, but fearful of police authority, and exceedingly clannish; as is not unnatural for foreigners in a strange country. Medical attention in case of illness is usually delayed until the severity of symptoms demands it, and any but severe ailments are likely to be followed by recovery without medical interference. They are attended when ill mainly by physicians of their own nationality, some of whom are unfamiliar with yellow fever. They are apt to resent the reporting of any case of communicable disease to the authorities, and are likely to dismiss the attending physician for this reason. Imagine a crowded population of this kind whose water supply consists in large part of river water, kept for settling purposes in numerous open barrels, each one an ideal breeding place for the *Stegomyia* mosquito.

For more than four years the health officer, encouraged and supported by the board of health, had pointed out the danger; had explained, urged, begged and prophesied, but other considerations were deemed of greater importance than the destruction of mosquitoes. When the disaster came, however, the people of New Orleans, awakened from a lethargic sense of security, rose to the situation and demonstrated their willingness and ability to fight the greatest battle that was ever waged against yellow fever; and they conquered. The united forces of the combined authorities of city, state and nation and the whole people of New Orleans succeeded in turning a great calamity into the most glorious victory of modern times. For the first time in New Orleans an epidemic of yellow fever was fought with the weapons suggested by the doctrine of mosquito conveyance of the disease, and for the first time extensive yellow fever was controlled as early as August.

The first victory over yellow fever was in Havana, the greatest in New Orleans.

The pictures exhibited show the character of the neighborhood first infected, its nearness to the landing place of the Havana steamers (I do not claim, however, that our infection came from Havana), and the facility with which infection could have gotten, and probably did get, to the luggers, the landing place for which is in close proximity; these luggers being connecting links with the gulf coast of Louisiana.

Suspicion was directed to this neighborhood of the city about the middle of July, but subsequent knowledge indicated the real beginning of yellow fever infection to have been probably several weeks earlier. At no time in the history of New Orleans did an epidemic of yellow fever begin to decrease as early as did the latest and we hope and believe the last one.

Never before was an epidemic of yellow fever in New Orleans fought in the same way, and the most skeptical of reasonable persons must conclude that the control of what would have been one of the greatest of yellow-fever epidemics was due solely to the prevention and destruction of mosquitoes.

Dr. James Carroll said in discussing Dr. Kohnke's paper: "The chart by which Dr. Kohnke shows that there was a marked increase in the death rates from pernicious malaria and acute nephritis in New Orleans during the months of May and June, 1905, proves conclusively to my mind that fatal cases of yellow fever occurred in the city during those months and that the disease was probably also present during the month of April. They recall forcibly to my mind an incident that occurred at Pinar del Rio, Cuba, in 1900. During a localized outbreak of yellow fever a number of deaths took place and though some post mortem examinations were made the cases were diagnosed "pernicious malaria with acute nephritis." The unusual mortality rate attracted attention and upon investigation it was found that the disease prevailing was yellow fever. As the records of innumerable epidemics show that where yellow fever is wrongly diagnosed

it is usually regarded as pernicious malaria or bilious remittent fever, and as death from yellow fever is usually accompanied by acute nephritis or parenchymatous degeneration of the kidneys, the explanation suggested is probably the correct one. This opinion is borne out by the record for July and the following months during which the excessive number of deaths from pernicious malaria and acute nephritis no longer appears, seemingly for the reason that yellow fever was declared in the month of July."

The Practical Side of Mosquito Extermination: HENRY CLAY WEEKS. (Presented by A. C. Eustis.)

In essaying to speak on such a theme before a body of scientists, it must not be understood that the purely scientific side is to be subordinated or is imagined to be of less importance than the practical. On the reverse, the methods under which practical work has been most successful are based entirely on the scientific work of the entomologists. It is through their patient labor that others have been encouraged to carry into practice their findings to their legitimate results. The scientific work of bacteriologists too has given great strength to the demand for practical work.

Without diminishing their share in the movement it may be truly said, however, that entomologists have always known the fact that the mosquito must have water in which to develop from the larval and pupal stages to the adult. But, as is very generally the case, these students have been, in former years at least, engrossed with the study of the life, habits and structure of these pests and did not carry, and indeed were formerly hardly expected to carry, the knowledge gained into the practical realms of extermination. They may be said to have been working at too close a range to see all the results which their knowledge implied. There was needed the more general survey over the entire subject by practical minds of persons, who knew, perhaps, only the basal facts about these pests, to bring about a great reform. Just as in the case of some one who confines his attention closely to his line of business, another in a different line will see opportunities of extension and profit which his closeness of appplication precludes. Thus there has grown up a profession of men who go from one business house to another more thoroughly practicalizing businesses of which they before knew little or nothing.

In this case, exceptionally, the suggestion of relief came from Dr. L. O. Howard, who combined both the student and the practical mind, and by his experiments and announcements brought hope that practical extermination on a wide scale was possible. And when Dr. Howard saw that there was even a broader and more radical relief possible than the use of oil (which idea he discovered to be of great practical though limited results) he was the first to encourage the broader idea of drainage when he observed this plan urged in the scientific press, as it was nearly

seven years ago, and it was he who gave the necessary inspiration and encouragement to practical men who were interested. The death knell of the mosquito then began to sound when Dr. Howard inspired the carrying into effect of known resources of destruction. To use a bull, some concluded that the best of extermination methods was to destroy the mosquito before he was born, and he endorsed the idea.

The world has moved toward practicalizing scientific knowledge rapidly in the last few years and this matter thus early fell into line. The mind of the entomologist who forcefully recommended the larger use of oil as a remedy, was simply going a step beyond his real field and applying his knowledge to practical uses—which should be the object of all scientific study and not the thing *per se*. And then this line of thought inspired the idea that if oil was good in a limited way why not go further, and to the root of the matter, and destroy the breeding places. The seed-thought, however, had been dropped some time before when a casual remark had been made that a certain place, before experienced by this speaker as unendurable, had been cleared of mosquitoes by a piece of commercial drainage, but it was the work of the entomologist, as before stated, to nurture the idea to fruitage.

So when plain, practical men, who knew little of entomology, saw that water was needed to develop the pest, they were just so practical, or unpractical, if you please—such visionaries—as to say: Let us do away with all water in inhabited sections where the pests breed. They simply put two and two together while heretofore these factors had been widely separated. And so widely and so long were they apart, that when the union was proposed the world laughed aloud and a few of a certain calibre of mind are laughing yet.

There has been many a great idea retarded for ages because of this spirit of ridicule, and many a man has gone down under such opposition who had a thought which, if encouraged, would have blessed mankind ages before its final acceptance. We can all think of instances of this. Insistency often has been lacking.

But, fortunately, the mosquito cranks were as persistent as the pests themselves. They kept at the subject until they reversed the universal practice and they themselves began to draw blood. And so, probably, no crusade, which at first seemed so chimerical, ever made such strides as has the mosquito crusade in the last three years or so, until now, that which less than a score of years ago began as an oiling experiment in a summer resort in the Catskills has spread to a crusade of drainage, filling and the like; and oil, which is indispensable in certain limited conditions is now largely supplemented by extensive engineering operations. Now, engineers of natural reputation are applying to their work the solid foundation laid by scientists and urging broad remedies upon communities and cities which have been sadly injured by the mosquito nuisance.

In a report (1903) on the improvement of a river in New England, an engineer, whose abilities have brought him into large projects in many sections of the country, makes the mosquito, and hence the malaria ques-

tion, one of the moving causes for a proposed improvement. He calls to his aid a Harvard pathologist of world-wide reputation who devotes many pages of this report to the mosquito question.

And in 1904, the same engineer reports on the improvement of another river, and gives prime attention to the results of investigations by the scientific experts from the Massachusetts Institute of Technology. Based on their reports, he is led to state:

"The results of this inquiry were startling. Every physician who was consulted testified that malarial disease was already prevalent and that it was apparently increasing and slowly extending."

He says:

"I was thus obliged at the outset to face a great sanitary problem which for the time overshadowed the other studies, for questions of public health are paramount and should have precedence over landscape design and facilities for brick-making or market gardening."

We may interject just here, that when health and all improvements go together, as can be planned, then is the greatest good accomplished. The experts speak of 700 acres of a fresh pond marsh section (300 of which are constantly wet and soggy) where "physicians report that every person in every house has had the fever," and many of them state that this is "the most dangerous section in twenty-five miles." While the poor who live in this swampy territory were most affected, the report shows the disease spreading into the best districts where it is hilly.

These lines of investigation and the results are in exact conformity to the work done and reported upon by the North Shore Improvement Association of Long Island, some years previously. And it is most encouraging that engineering works are now being undertaken with such a strong appreciation of the importance of the mosquito question.

Landscape architects are seeking informing literature and are studying the subject and discovering that their profession also can materially aid the crusade and are recommending plans with a view to this question.

These two professions have been sadly blind to their opportunities for good. Not only has their work been simply negative—that was bad enough with their opportunities—but they have actually aided breeding in most cases. Within a few days the speaker has interested an owner in a badly infested home-site who has been spending thousands of dollars in following the plans of eminent landscape architects as to the lay-out of the wide lawns in front of his dwelling, while just in the woods behind there has existed for ages and still exists a breeding place extensive enough to ruin the pleasure which his home should yield him; and a surplus of pests to curse his neighbors Now, this man is moving vigorously to get rid of this pest place, not that it has not been known heretofore that mosquitoes would breed in such places, but solely because it has been demonstrated that such work is entirely practical and certainly is highly desirable for comfort, for health, for increase in the value of his property and in the vast improvement to scenic effects. This is simply a case of neglecting

a grand opportunity, but when these professions actually produce breeding grounds, their acts become a positive wrong to the public.

A gentleman of large means, recently met, has been encouraged to work on these lines on his vast property and now assures the speaker that he considers the question one of the most far-reaching before the people. This we have been endeavoring to show for nearly a decade. He feels that no money he is spending on roads and other improvements will pay him better. He also assures us that in the immediate vicinity where he has done work, which this crusade encouraged, he plainly notices a great difference in the number of pests and he is going to continue the work with vigor for its absolutely paying results.

A little town in New England of less than a thousand inhabitants, whose chief industry is fishing, has recently become impressed with hope founded on experiences elsewhere, that something might be done so that its thousands of acres of breeding grounds might be redeemed to agriculture, its desirable building sites relieved from the curse of mosquitoes which has always existed, and thus its lands become habitable, its taxable valuations increased, and so the town be greatly benefited. Inspired to join the crusaders, it had been working in a limited way and found excellent results, but it is now in a movement for raising and expending a large sum of public money to carry out very radical plans recommended to make these benefits assured and is asking the necessary legislative authority.

We know the case of the gentleman who bought a beautiful and extensive estate with the ban on it, that no one could live on it in July and August, but who was impressed with the anti-mosquito theory by that same entomologist with the practical turn of mind, and went to work in good earnest and has made his large tract one without mosquitoes. His success led him naturally to wish others to be blessed likewise and he was instrumental in a campaign of greater proportions. One in this wider territory wrote the speaker within a few weeks that the success of the work was still continuing, although four summers had passed; and a person in another state has stated within a few days that he was visiting in the district in question this season and went through parts which he knew once to be infested beyond human endurance and he did not raise a mosquito. So much for the lasting effects of work thoroughly and practically executed.

But I am sure I do not need to rehearse smaller instances when all know of the transcendent achievements of Dr. Gorgas, both in Havana and in the Panama zone almost entirely as the result of practical mosquito extermination. Nor do you need to be reminded that the practical work of this kind in New Orleans, first under Dr. Kohnke and others and taken up later by the general government with all its prestige and power, through its Public Health and Marine Hospital Service under Surgeon General Wyman, with his able corps of specialists all working against the mosquito—that *this* brought about the end of the scourge of yellow fever here this season without the aid of frost, and has added to the demand

that this scourge and its attendant ruinous results to commerce through quarantine, be treated solely as a mosquito proposition and not as an inscrutable order of Providence. The speaker well recalls the force with which Dr. Kohnke at the second convention of the American Mosquito Extermination Society urged the necessity of screening the cisterns of New Orleans and spoke of his efforts to legally compass this. But his warning was acted on too late. He was then ahead of his time, but we are glad to say he is not now.

The demand is simply: Stop breeding mosquitoes and stop it by practical measures—no chimerical plans—nothing but what a child may comprehend. But do it throughly—do it so that results will last. Abolish forever the breeding places and be careful not to make new ones. Communities should put up money as they would to build a fine road—as is often the case, $10,000 a mile through a mosquito-infested section—and do it *before* building the road, and then the road, when built, can answer its full purpose of comfortable travel and traffic.

How much is the quinine bill of the country? And who can estimate, besides, the sum of the misery and loss from malaria? Who will compute how far the loss in a yellow-fever epidemic would go to make everything safe along practical, common-sense lines? Is it not a fact that the expense of tardy work and the indirect and direct commercial losses resulting from this season's experience would easily have paid for New Orleans's exemption? How long are we to suffer these evils and pay the enormous and wretched penalty before people will rise and demand that this great crusade shall have complete course? This age is not the time to say that the work is too great. Put one year's loss and the cost of remedies, the country over, into the crusade, and it will be a paying investment financially, not to include other considerations. But again, do it thoroughly, so that you will not have to come back again in another year, or in ten years, for more money. Otherwise you have set back the cause for years. Note the radical work which the general government is doing in Panama and which it considers as necessary in every way before work is fully put under way. We said a year ago that the government could well spend a million dollars to make the zone safe. That has been spent already and results will justify the outlay and many times as much more. Chairman Shonts, of the Isthmian Commission, in an address last month expressed the well-grounded hope that yellow fever, that supreme terror of the tropics, was extirpated—never to return again to Panama. Can one conceive all that such a statement means in relation to the cost and humanity of this great work?

Assistant Surgeon General Gorgas, in his report dated November 9, 1905, just to hand, reports that of the 22,000 employees during October, of, which 4,000 were non-immunes, there was but one case of yellow fever and no deaths. He pertinently contrasts conditions for the same month in the zone now and under the French régime before the mosquito theory was known. Then there were reported 21 deaths and 84 cases, and many of each were not reported. Now he has care of one-third more non-im-

munes and there is only one case. He maintains "the results are solely and entirely due to the sanitary measures put in force." He has an anopheles brigade reporting thousands of feet of ditches dug and cleared and other remedial work; and a stegomyia brigade reporting and remedying tanks, cisterns, barrels and other breeding places. To overcome the dangers from these pests which get to wing, he has a fumigating brigade, reporting houses fumigated containing 12,000,000 cubic feet, using 18,000 pounds of pyrethrum and 7,800 pounds of sulphur. Dr. Gorgas finds a steady decrease in cases of yellow fever under this work, while there is a steady increase in the number of persons susceptible. He considers the sanitary question in Panama settled—that the largest necessary force of laborers can work there without suffering from yellow fever and that "the general health can be kept as good as if they were digging a canal in the healthy part of Maryland." Now all this you may hear stated by others, but bear in mind it is the practical side of mosquito extermination we are trying to emphasize, and this is all practical and highly profitable in every way and bears well to be repeated. Also recognize that to some extent such work is necessary in many communities in the states and that it is just as profitable here in a humanitarian view as a financial proposition and in other aspects.

No progressive man will object that the general government is spending hundreds of millions on good roads, on irrigation, on river and harbor improvement; that the Empire State votes 150 millions for good roads and canals; but when it is considered that in some of these cases the benefit will come only to sparsely settled sections and result in aiding comparatively limited areas and valuations, the thought arises, why should not some of these vast sums be used in blessing the country by driving out the mosquito and malaria and yellow fever, bettering the condition of the less favored people—for they suffer most—changing marsh and swamp areas into places of fertility, beauty and oftentimes into places of pleasant habitation? When it is considered that such work is largely needed in close centers of population where thousands will be benefited instead of scores, and where resultant increase of tax valuations will shortly entirely repay cost, the urgency of the subject as a public work is manifest. This body and all others working for the general good should state and reiterate this position until we get public action.

It has taken some years to get strength enough in the idea to obtain appropriations, but these are now coming in many places. Numbers of cities and communities are awakening and acting. The Department of Health of the city of New York has been expending this season in one borough—Richmond—an appropriation of $17,000 under Dr. A. H. Doty, the health officer of the port, and it is to be hoped the results will encourage work in other boroughs. But all public work particularly, we repeat, should be done most thoroughly, or the press and people will raise such opposition as to cause a set-back in the practical work of a thoroughly scientific problem.

The city of New York is also helpfully acting in the reform by utilizing part of its inorganic waste in filling in breeding places instead of carrying it out to sea and dumping it so that much floats back on to adjacent shores. In the southern part of the borough of Brooklyn, Coney Island Creek is being filled in, which, guardedly done, will prevent its waters from saturating hundreds of acres of marsh land where mosquitoes are now famous. This evil and this benefit were pointed out some seasons ago when a crusade was initiated there by the late Mr. Wm. C. Whitney.

Some two or three years ago we were greatly encouraged in learning that the Italian government had made a contract with some German capitalists to drain the great marshes about Rome to destroy the breeding places of mosquitoes and thus render the section healthy and habitable. But it seems that this great improvement and blessing to a race has been kept back until now by the obstruction of a few sporting noblemen (in title) who wished to have the marshes left for their personal pleasure. Now the press informs us the work is to go forward and the promoters are to be paid in hitherto worthless land. What a suggestion for our country along lines of marsh improvement and the obstruction met from personal interests of a few who seek pleasure or profit.

The great benefits of mosquito extermination we feel are to be accomplished by a careful education of the pubic mind and a judicious effort for laws and public appropriations, by cooperation of general and state governments, of cities and rural sections, of individuals and public men in a short, strenuous campaign. What need of taking decades in these moving times? And it is on these lines that the American Mosquito Extermination Society is earnestly working, and I bespeak for it your influence and cooperation.

It would take too much of your time to speak of this phase—the basal work, education—education of the public school children of the country, the lawmakers, the editors and press writers, the civic organizations, the professions interested, the great mass of the people. But this work our society is striving to do and has its members distributed well over America, to whom our literature is scattered, and we frequently hear of its bearing good fruit in campaigns. In our society, either as officers or on the advisory boards, are many men of broad influence in the country. Among these the earliest to go into the movement, inspired by the entomologist before referred to, were Matheson, Kerr, Miller, Hoyt, Cravath, Rand and Wetmore—business men of largest affairs.

We have got such men together, with many others known over the world, into a society, which, according to its constitution, seeks "to unite in a general body, persons believing in the various great evils resulting from the unrestrained breeding of mosquitoes in civilized sections, and in the practicability of their extermination therefrom, by private and public systematic operations."

For these worthy objects we ask your active cooperation with us and in closing thank you for your attention.

Without Mosquitoes there can be no Yellow Fever: JAMES CARROLL.

It seems incredible, but is nevertheless true, that at the present time there are still in the United States many physicians who oppose the idea that the mosquito is the sole means by which yellow fever is carried from one person to another. They refuse to believe that the natural disease can not be contracted in any other way than through the bite of the mosquito. The fact, however, has been repeatedly demonstrated and the evidence in its support has now become overwhelming. The tremendous importance of this subject, in a city which, by reason of her location and commercial intercourse with Central and South America, may be regarded as the gateway through which a disastrous epidemic may at any time be introduced into the United States, is my apology for again taking up so trite a subject. It is the duty of those who are familiar with the facts to communicate them to the members of the profession, for the people must rely upon their physicians in all matters pertaining to the preservation of health and the prevention of disease. We can not expect that the active practising physician shall keep abreast of all modern advances in scientific medicine, and the numerous contradictory statements that have been made in regard to yellow fever have afforded full justification for skepticism on the part of such as aim to be conservative. While strong conservatism is to be commended, persistent skepticism is to be condemned. It is perfectly justifiable to refuse to receive statements that revolutionize our accepted ideas, so long as they are based upon the assertions of a single observer or a single set of observers, but when these observations have been confirmed by competent unbiased persons in different parts of the world, such statements must then be accepted as facts, just as we accept other statements in regard to history, geography and the sciences in general.

It is well known that a number of disease-producing animal parasites are never found in nature outside the body of a living host. They pass their whole existence first in one animal and then in another, alternately, being carried to and fro by means of biting insects, by the ingestion of infested food, etc. It is only necessary to consider here the group of parasites that is transmitted by the blood-sucking insects, such as the tick and the mosquito, the latter in particular. We know that the Texas fever of cattle is caused by an exceedingly minute microscopic parasite which spends its whole existence in bovines and in the tick. If cattle are kept free from ticks they can not contract the fever. Furthermore, the tick is now accused, and with good reason, of being the transmitter of relapsing fever. It is equally well known and proved beyond question that the mosquito transmits filarial infection and malarial fever to man. No one would think of asserting in print to-day that malaria is contracted through exposure to night air, to unhygienic surroundings or by drinking the filthiest water, for such statements would justly be characterized as absurd. The renowned experiments of Sambon and Low in Italy, in 1900, showed conclusively that persons can live in the most pestiferous

malarial regions and retain perfect health, so long as they protect themselves against the bites of mosquitoes. In the same year these observers shipped living malaria-infected mosquitoes from Italy to England, where they were applied to two persons in perfect health in a region where malarial fever is unknown. Within a short time both of them suffered typical attacks of malaria, during which the parasites were frequently demonstrated in their blood. Fortunately the various stages in the development of the malarial parasite in man and in the mosquito can be demonstrated with the microscope. We know that the phases it passes through in the insect are entirely different from its cycle of development in man, and no one has as yet succeeded in demonstrating the existence of this parasite elsewhere than in a living host. Such a demonstration is not necessary, for with our present knowledge we can explain all the known facts relating to the contraction and dissemination of the disease and we can insure absolute protection against it. We no longer attribute malarial infection to the inhalation of gaseous poisons emanating from swamps in the night time, or to bad water. We know that swampy places simply furnish breeding grounds for the malaria-carrying mosquito, which flies at night, and whose bite is necessary for the contraction of the fever. The insect must previously have bitten a person suffering with malaria, and an interval of at least a week must have elapsed, otherwise no infection can result. The recent brilliant discovery by Koch, that apparently healthy negro children in the pestilential districts of Africa constantly carry large numbers of malarial parasites in their blood, explains the source from which the mosquitoes obtain these parasites; it also explains the relative immunity against this infection enjoyed by the negro.

If we now consider the numerous points of similarity between malaria and yellow fever they will be found to be very striking. Both are diseases of low-lying districts; both infections are contracted chiefly at night; both may be conveyed by direct inoculation of the blood of a patient; both are most prevalent in the places and seasons where and when mosquitoes are most numerous; both infections are impossible after severe frosts, which cause the mosquitoes to hibernate. These constitute strong points of resemblance between the two diseases, which differ from each other in that the duration of yellow fever is very short, while malarial infection may persist for years. Unfortunately, the parasite of yellow fever has never been found, in spite of claims to the contrary, and notwithstanding the use of the best powers of the microscope, and even the ultramicroscope, in the efforts of skilled observers to discover it. That there is a yellow-fever parasite we feel assured, because it is not possible to explain the continuous propagation of the disease upon any other hypothesis, and apart from its invisibility, the manifestations of its presence are in complete accord with the behavior of parasites that are well known. We must not forget that the minimal limits of creation in nature may be beyond our conception, and we must be prepared to learn, if necessary, that there are living bodies too minute to be defined with our present instruments.

The report of the latest scientific investigation of this disease by Otto and Neumann, of Hamburg,* members of the German commission, working in Rio de Janeiro within the past year, states that they were totally unable to find anything either in the blood or in the cerebro-spinal fluid of patients suffering with yellow fever, that could not be found in similar material obtained from persons suffering with other diseases and from persons in good health. In this work they used the ultramicroscope of Siedentopf and Zsigmondy. Neither could they find anything in the infected mosquito after dissecting it in the fresh state, nor after hardening and sectioning it, that they felt justified in regarding as the cause of the disease.

How then are we to explain this failure to discover a parasite in an apparently parasitic disease? And, if a parasite be present, to what class does it belong? It seems quite rational to exclude it from among the bacteria because: (1) It has never been cultivated nor stained by any of our known methods; (2) the work of Marchoux, Salimbeni and Simond has shown that the blood of a patient after its withdrawal loses its power to infect within two days, if kept exposed to the air, and within five days if air be excluded; (3) the disease has been shown to be absolutely non-contagious in regions where *Stegomyia fasciata* is not present, *e. i.*, in Petropolis near Rio de Janeiro; (4) we know no bacteria that live in the tissues of animals, as the yellow-fever organism does in the mosquito, for months, as a harmless parasite. The logical conclusion, therefore, would seem to be that the parasite of yellow fever belongs to the animal kingdom, because: (1) It is absolutely necessary for its continued existence that it pass alternately through man and the mosquito, and its parasitic existence in these hosts is obligatory; (2) the fact that a period of about two weeks or more must elapse before the contaminated mosquito is capable of infecting, points to a definite cycle of development in that insect; (3) the limitation of its developmental cycle to mosquitoes of a single genus, and to a single vertebrate, conforms to a natural zoological law and does not agree with our present knowledge of the life history of bacteria; (4) the effects of climate and temperature upon *Stegomyia*, and upon the rate of development of the yellow-fever parasite within the body of that insect, are exactly the same as the effects of the same conditions upon the *Anopheles* mosquito and the malarial parasite.

Consequently, although on account of its minute size no one has ever been able to identify the organism of yellow fever either in human blood or tissues, or in the mosquito, we feel justified in regarding it as an obligate animal parasite. If this be correct it can not maintain its vitality in water, in soil nor in any other material, no matter how badly they may chance to have been contaminated. Experience and experiments have shown that such is actually the case; that dead bodies can be freely handled and dissected by non-immunes without danger; that non-immune persons may live in intimate contact with the garments, bedding and clothing

*M. Otto and R. O. Neumann, *Zeitschrift f. Hygiene u. Infectionskrankheiten*, LI, 3, November, 1905.

used and soiled by yellow-fever patients, under the same conditions and in the same climate where yellow fever has prevailed, and suffer no inconvenience. And further, it has been shown by the French commission that this organism fails to survive in blood, a most excellent culture medium, after it has been kept for forty-eight hours under ordinary conditions. This undoubtedly proves the inability of the organism to maintain its vitality in filth or decomposing organic matter.

Yellow fever is non-contagious, for in our medical literature numerous instances are recorded where numbers of patients were brought to certain places for treatment and no secondary cases resulted. This was before the days of disinfection, before any precautions were taken against mosquitoes, and at a time when intercourse with the sick was free and unrestricted. These strange occurrences were observed in Spain during a severe epidemic at Barcelona in 1821, during which, under the supposition that the air of the city was infected, there was a general exodus to the country. Here hundreds came down with the disease and were treated, but not a single case was recorded to have appeared in a person who had not visited the city. Yet tons of furniture and baggage were carried from infected houses into the country. All this took place in a warm climate and during the ravages of a devastating epidemic. Such remarkable occurrences were inexplicable mysteries that puzzled the most brilliant medical minds of the day; they could only be explained upon the theory that the air of the city had become contaminated. And so it had, but not with poisonous gases and noxious vapors as they supposed, but with infected mosquitoes. In the light of the mosquito theory the explanation is clear. An epidemic prevailed in Havana during the early part of that season, and a number of cases appeared on vessels after leaving there for the Spanish port, where the epidemic appeared later in the season. The first cases in Barcelona were seen on the vessels from Havana, lying in the harbor; then persons living in the city, but who had visited or were employed on the vessels, were taken sick; and later, the epidemic raged throughout various parts of the city. It is quite evident that the vessels carried infected mosquitoes as well as others that were not infected; these mosquitoes bred rapidly in the houses on shore and the conditions then became ripe for a rapid extension of the disease after the introduction of a few cases. It is to be noted that vessels were constantly arriving from Havana; these cases appeared on the ships during the voyage and, until suspicion was aroused, patients from the vessels were treated on shore. The *Stegomyiæ* introduced from the vessels, being house mosquitoes, remained in the city, while the country districts were free from them, and for that reason free from any extension of the fever. The absence of the proper mosquito is the only explanation that can be offered, and in the light of our present knowledge, it is all-sufficient.

In the United States, both before and since the epidemic at Barcelona, there have been similar outbreaks, always introduced by importation, though frequently regarded as of endemic origin, *i. e.*, at Philadelphia, Baltimore, Norfolk and New Orleans. In the latter city the danger is

particularly great, because *Stegomyia*, being always present, will readily spread the infection if it encounter a sufficient number of non-immunes.

Another good case in point is Petropolis, twenty-five miles from Rio de Janeiro and at an elevation of 3,000 feet. Yellow fever is never known to occur there, spontaneously, and for that reason it has been made the home of non-immunes who spend the night at Petropolis and visit Rio during the day for the transacton of business. While there are no *Stegomyiæ* at Petropolis, the French commission showed three years ago that the disease can be produced there by inoculation with infected insects. At the present day one who seeks can find abundant evidence to show not only that the mosquito transmits yellow fever, but that without the agency of the mosquito it is impossible to have yellow fever, except by means of experimental inoculations.

Since the first demonstration of the mosquito theory by the army board in 1900, confirmatory experiments have been made by Dr. John Guiteras of Havana, Ribas and Lutz of Brazil, the French commission from the Pasteur Institute, Working Parties No. 1 and No. 2 of the U. S. Public Health and Marine Hospital Service; and lastly the German commission from Hamburg, admit no other possibility. The latter, whose report was published only two months ago, lays great stress upon the necessity for the extermination of mosquitoes in localities where yellow fever appears in epidemic form, because, they say, without the mosquito, extension of the disease is impossible. They advocate complete extermination of the insect, and speak with enthusiasm of the success that has been attained in Rio, in spite of the opposition of a number of local physicians and of a rather large proportion of the population. As a result of their observations in Rio, they maintain postively that the natural form of yellow fever can be contracted only through the bite of an infected mosquito of the genus *Stegomyia;* they are so firmly convinced of this fact that they decline to consider the possibility of any other mode of infection since they could find no evidence in support of it. They found the yellow-fever mosquito everywhere in the city of Rio, but in Petropolis, where the French commission before them could not find it and where yellow fever is known never to spread, they failed to discover a single specimen. If one could say the same of New Orleans another outbreak of yellow fever there would be an impossibility, except when the mosquito as well as cases had been introduced. According to Otto and Neumann,* authorities in Rio are about to adopt the admirable system of providing a mosquito-proof barrack for laborers in the harbor and docks, and they will keep the men under medical supervision, in order that any cases occurring among them may be protected at once from mosquitoes. This will insure that no secondary cases shall be produced by infection from them. They urge the necessity for protecting patients from mosquitoes during the first three or four days of the fever, because it is only during this period that the mosquito can acquire the infection. They state em-

*The German commission.

phatically that in combating an epidemic all preventive measures should be directed against this insect and its relation to the patient. After proper protection of the patient all suspected mosquitoes must be destroyed and efforts should then be made to exterminate all *Stegomyiæ* present in the locality, if possible.

Under the efficient management of the director of public health, Dr. Oswaldo Cruz, who is himself an experienced scientist, over $55,000 per month was expended in Rio de Janeiro, from April to December, 1903, in the war against mosquitoes. Even the main sewers were fumigated and myriads of mosquitoes destroyed in them by the use of sulphurous acid. A sanitary brigade was organized into sections for operation in the different districts into which the city was divided. The personnel of this brigade comprised about 2,000 men, including 80 physicians. Their duties were specifically defined as:

(1) The isolation of yellow-fever patients and their protection from mosquitoes, including the necessary arrangement of the isolation rooms; (2) the destruction of mosquitoes in the house and its surroundings and the destruction also of their breeding places; (3) the removal of the patient in a screened conveyance from his home to the hospital, if he desired it, or if it were impossible to isolate him in the house and the public interest demanded it.

All suspicious cases were treated as though they were cases of yellow fever and half-way measures were not tolerated.

A manifesto setting forth the relation of the mosquito to the disease and the necessity for the measures instituted was published on April 26, 1903, for the instruction of the people, and I can not do better than cite a few extracts from it to show the positive conviction of those in authority, who had already witnessed the confirmatory experimental work of the French and Brazilian commissions.

EXTRACTS FROM THE MANIFESTO.*

* * * * * * * * *

2. Yellow fever is not conveyed from person to person, nor is it transmitted by means of soil, or articles used during illness, the sole means of transmission is by the mosquito, as has been fully determined.

3. Several days after biting a case of yellow fever the mosquito acquires the power to transmit the disease, and it preserves that power for some time, two and one-half months or more. The domestic habits of the mosquito explain sufficiently why yellow fever is a disease that establishes itself in houses and why it is contracted only in cities.

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*J. Dupuy, "Epidemiologie de la Fievre Jaune," *Revue d'Hygiene et de Pol. San., Paris*, 1905, XXVIII., 13-29.

8. During epidemics, when the disease is at hand, all healthy persons should have mosquito nets upon their beds at night, and they should take care not to be bitten by mosquitoes during the day, because yellow-fever mosquitoes bite also in the daytime.

The new harbor regulations for vessels entering with yellow fever on board are in part as follows:*

* * * * * * * * *

(*a*) The sick are immediately removed and isolated with mosquito netting.

(*b*) The mosquitoes in the entire vessel are killed systematically and their breeding places are destroyed.

(*c*) Passengers who intend to stay in the harbor receive a health certificate and are subjected to medical supervision for twelve days.†

(*d*) The vessel is then admitted to free intercourse, but admits a health inspector on board, who will accompany the vessel to its last Brazilian port and who proceeds as follows: (1) He examines daily with care all the passengers and the crew, and isolates with netting any who show symptoms of fever. (2) If mosquitoes be present their immediate destruction is ordered at once.

* * * * * * * * *

I have cited only a few paragraphs to show that the authorities have thoroughly grasped the situation and their ultimate success is assured. The gigantic nature of their undertaking in an unsanitary sub-tropical city of more than a million inhabitants can hardly be conceived, and their enlightened and determined efforts are exciting the admiration of the scientific world. With continued perseverance they will eventually attain the same degree of success that has been achieved in Cuba and their example will be followed by the smaller Central American republics.

After four years of immunity Cuba has been caught napping. According to the last report of the U. S. Public Health and Marine Hospital Service‡ she has had seventy cases of yellow fever, with fifteen deaths between October 16 and December 17. Two of the cases were imported. According to the newspapers six additional cases have been reported up to December 25. While the condition is serious, there is no epidemic and

*Otto and Neumann.

†This is based on the prolonged periods of incubation reported by Marchoux, Salimbeni and Simond, and is unnecessary, because it has never been shown conclusively that an incubation period of more than six days and a few hours can follow a simple mosquito inoculation. In every instance in which a longer period of incubation is proved the subject received injections of either serum or blood. These observations therefore can have no practical bearing on measures directed against the natural infection which is produced by the mosquito alone.

‡Public Health Reports, Washington, December 22, 1905, p. 2,739.

the authorities have the situation under control. The large number of cases relative to the deaths reported shows that but few, if any, cases escape detection. I feel sure that the disease will be eradicated within the next two months. One or two or a few cases may appear in the early spring because some of the infected mosquitoes may escape fumigation and survive through the short winter. There is no reason to apprehend, however, that Havana will again become seriously infected.

Although I am now two years beyond the half-century mark, I think I can reasonably expect to live to see the day when yellow fever shall have been exterminated from the whole American continent, and that means practically from the world. Let us hope that the beautiful city of New Orleans will never again be devastated by the American plague from which she has suffered so terribly and so often. The price of safety is eternal vigilance; the greatest danger from yellow fever lies in the escape of mild and doubtful cases. One of the first to apprehend the full import of the mosquito theory was Dr. Quitman Kohnke and I can recall with what pleasure I listened in Washington, several years ago, to his able, courageous and masterful contention for it, before a rather unsympathetic audience.

In the sad experience here during the past summer, we have seen an effectual demonstration by the various officials under Doctor White of the efficacy of measures directed against the mosquito. With this and the evidence already brought forward by Guiteras and the French, German and Marine Hospital Service commissions, it should never again be necessary to contend for the well-proved fact that without the agency of mosquitoes there can be no yellow fever.

Æstivo-autumnal Fever—Cause, Diagnosis, Treatment and Destruction of Mosquitoes which spread the Disease: H. A. VEAZIE.

Synonyms: "Summer-autumn fever," "pernicious malarial fever," "congestive malarial fever," "hemorrhagic malarial fever," "up-river yellow fever."

Geographical Distribution.—This is a fever that prevails in nearly all parts of the world where the *Anopheles* mosquito is found, and is influenced to a greater or less extent by climate; a pseudo-epidemic fever that prevails in tropical countries the year round. In semi-tropical and temperate climates it prevails from about July 1 to the appearance of frost.

Etiology.—The cause of æstivo-autumnal fever is a parasite, a living micro-organism, a protozoon in the blood which enters the red blood corpuscles and destroys them, and in time is destroyed by the white blood corpuscles if the patient lives; otherwise, the destruction of the red blood corpuscles and toxins formed by the parasite kills the patient if proper remedies are not used, or if the white blood corpuscles are not sufficiently strong to overpower the parasites. This parasite of æstivo-autumnal fever was studied extensively by Welch, and named by him the *Hæmatozoon falciparum.*

A peculiarity of this parasite is that it seems to abide in the internal organs such as the liver, spleen, kidneys, bone marrow and even the brain; hence many of the cerebral symptoms of the disease. This parasite is the third form of malarial parasites. There may be a fourth form which causes what we now call yellow fever and like many other diseases yellow fever may become obsolete as to name and possibly be classified as malarial. I have almost at times convinced myself that the two diseases were one and the same, but for the following reasons: in yellow fever there is no change in the number of red blood corpuscles, whereas, in malaria there is great change. In malaria the fibrin seems to be normal as to coagulative properties; in yellow fever the fibrin of the blood loses that important characteristic.

How does the parasite of æstivo-autumnal fever get into the blood? This is now well understood. It is through the agency of the *Anopheles* mosquito, and in all probability the *Anopheles crucians*, as the prevalence of this fever corresponds quite well with the flight and distribution of that mosquito. I would not consider this the only host for this parasite. Let us consider that all mosquitoes are guilty, and destroy them, at least for sanitary purposes. It is well known now that the mosquito bites an infected individual and the infected blood is taken into the stomach of the mosquito; there the blood is digested and the micro-organisms after going through certain changes, which are quite well known, form spindle-shaped objects which perforate the stomach walls. These are the zygocytes which go through different changes and finally get into the salivary glands of the mosquito, and are injected into the tissues of man's body, then in going through other series of changes produce the malarial parasite which we see in the blood of persons suffering from malarial fever. The cycles in the life history of the parasite are described minutely in most text books on the subject.

The author presented many facts bearing on the clinical history of the disease, its diagnosis and treatment. (See Science, N. S., XXIII, pp. 409–415.)

With regard to the extermination of mosquitoes the author spoke as follows:

The destruction of infected mosquitoes in homes, ships, etc., is best done by culicides. Sulphur kills them and other insects, but is so destructive to things such as furniture, delicate fabrics, etc., that people will not use it; pyrethrum is expensive and does not kill; it simply stupefies. Dr. J. H. White, knowing these difficulties, appointed a committee to investigate culicides. This committee was composed of the following members: Dr. J. H. White, president; Dr. Rupert Boyce, vice-president; Dr. Donald Currey, Dr. W. H. Perkins, purveyors; Dr. Q. Kohnke, Dr. H. A. Veazie, secretaries.

The committee, after trying various substances, tried the culicide of Mr. J. C. Mims, the analytical chemist of this city, and chemist to the city board of health. This culicide was first used by him to kill mosquitoes,

after years of experimentating with various substances. He tried equal quantities of gum camphor and crystallized carbolic acid, and found that it was most effectual as a culicide, and I am quite certain it is a most excellent germicide, as it should be theoretically and as has been shown in some recent experiments. This culicide is made of equal quantities by weight of carbolic acid and gum camphor. The crystals of the carbolic acid are melted by gentle heat and poured over the camphor, and the clear liquid is colored blue, by methylene blue, simply for safety's sake.

The liquid is volatilized by heat. The vapors kill all insects, mosquitoes most effectually, and destroy or injure nothing whatsoever except animate things. This culicide and disinfectant was used most extensively last summer in the most elegant houses, Pullman cars and ships with the most satisfactory results. Every imaginable insect, such as mosquitoes, flies, roaches, etc., was killed by it, and nothing whatsoever, except living things, injured. The expense of this culicide is between that of sulphur and pyrethrum. It is far better than either. It is safe when properly used, and kills insects from the top of the room to the floor, when used in proper quantities, three ounces to the thousand cubic feet. All broken panes of glass must be covered and pasted, ventilations closed, and fireplaces of room closed up so that none of the vapor escapes. The only trouble was that connected with generators, which had to be effectual and safe, as the liquid is somewhat inflammable but not explosive.

I have constructed a generator which answers all purposes and is safe. I am in hopes of having them made in quantities, so that if necessary, this culicide can be used extensively. It is absolutely certain that this culicide and disinfectant injures nothing but living things. The most delicate fabrics, metals, etc., are unaffected. I would be pleased to give any information to any one as to its efficiency. For lack of time, I can not speak further of this most wonderful agent

WM. J. GIES,
Secretary.

EXECUTIVE PROCEEDINGS.

EXECUTIVE PROCEEDINGS.

REPORT OF THE GENERAL SECRETARY.

The third meeting of the association was held in Charleston, S. C., in 1850. At that time there were 622 members. The number at the meeting is not given. It was probably a negligible quantity, for until 1905 the experiment of a meeting in the south was not again tried; though, of course, the failure to meet again in that section was largely due to the fact that until recently the only time available for an annual meeting has been the hot summer months. The registration at New Orleans was 233. The attendance of unregistered members of affiliated societies would raise this number to a probable total of 300.

It will be noticed that a comparatively small number of affiliated societies thought it wise to follow the association on so long an excursion from the usual places of meeting. Assurances have been abundantly given, however, that in the New York meeting most of the societies usually affiliating will resume that relation to the association.

The meeting of 1904 reported 4,175 members, that of 1905 about 4,500. The increase has been larger than usual, and important. As soon as the association can count on 5,000 active members most of its financial problems will be solved. It is a question whether as a means to this end some special arrangement should not be made with the members of affiliated societies who are not yet members of the association. Certain it is that the experience of America, as well as that of France and Great Britain in the same general field shows that the American Association fills a place peculiarly its own. The loss of its unifying influence and its aggressive propaganda of science would leave a void which nothing else could fill. There should be no difficulty in reaching harmonious relations satisfactory to all interests.

The experience at New Orleans makes it doubtful whether the experiment of scattering the vice-presidential addresses through the week is a wise departure. The meeting loses the initial momentum of a more compact arrangement.

The suggestion was made at this meeting that a distinctive badge for life members of the association should be designed and sanctioned. The idea is worthy of consideration.

The association has finally acted upon a suggestion long discussed and will undertake during 1906 two meetings, one in the summer at Ithaca, N. Y., the other in winter at New York city.

While the New Orleans meeting was small in numbers and somewhat expensive to individuals, still it was a decided success. The quality of the

welcome to the south was remarkably fine. Those attending believe that an unusual work has been done in the advancement of science and that, though the meetings will usually be necessarily small, the association should more frequently convene in the remoter and unvisited cities of the country.

The following affiliated societies held sessions in conjunction with the association:

The American Chemical Society.
The Botanical Society of America.
The Botanical Club of the Association.
The Association of Economic Entomologists.
The Entomological Club of the Association.
The American Mycological Society.
The Sigma Xi Honorary Scientific Society.

In accordance with its established policy the association encourages the great national societies to meet in connection with it. The paid officers of the association take charge of all matters of detail without charge to the societies. At New Orleans the number thus affiliating was much smaller than usual, but this was expected, because of the great distances of the centers of gravity of these associations from that place. Those few, however, which came south on this occasion with the association, will join in the conviction that they accomplished a genuine service in the advancement of science.

The first session of the fifty-fifth meeting of the American Association for the Advancement of Science was called to order in Temple Sinai, New Orleans, at 10 A.M., Friday, December 29, 1905, by the permanent secretary, Dr. L. O. Howard, who stated that retiring President Farlow was ill and would be compelled to remain in bed during the day, but expected to be well enough to deliver his address at 8 P. M. Dr. Howard then introduced President Calvin M. Woodward, who assumed the chair. President Woodward expressed his regret at the indisposition of Dr. Farlow, and said they had met to receive a special word of welcome from the great state and city which were the hosts. It was a very great pleasure to him to call upon the representative of the Governor of the State, who was personally unable to be present and was glad to have the Hon. Chas. F. Buck to represent the Governor on this occasion.

Mr. BUCK: Mr. President, members of the American Association for the Advancement of Science, ladies and gentlemen: His Excellency, the Governor, desires me to express, first his regret at his inability, by reason of other important engagements, to be here to greet and welcome you in person, and he has done me the honor to appoint me in his stead, to express that welcome to you in his name and in the name of the people of the State of Louisiana.

I know there is a majesty and power and grace in office which, my words lacking that grace of authority, may not be able to supplant, but

I shall not lack in sincerity and good will, in anything that even the official and foremost representative of our people could say to you.

It is an event of great significance to New Orleans to have so distinguished a body of men, the great scientists of this expanding country, coming far away from their homes to have their meeting, their reunion, their sessions, and, above all, their important practical work, accomplished in our midst.

It would be presumptious on my part, Mr. President, and a useless waste of time in such a presence and before such men whose lives are devoted to study and research and to the opening of the secrets of nature and extension of knowledge for useful application in all the domains and modern machinery of life, to talk to you of that which you have brought with you and of which you know much more than I do.

A mere glance at the achievements of science during the fifty-four years of the existence of your Association, would take hours to do justice to; and particularly has American science a right to be proud, ambitious and to think of great things for the future, when we briefly consider one or two of the achievements which have been wrought; in the electric telegraph and in the minor inventions, the sewing machine for instance, as well as in the wonders of electricity, in which I believe American science leads the world.

Science to-day has acquired a plain and practical significance. The day when the scientist was looked upon as a mysterious being, as a necromancer and as one forming an unholy alliance, seeking forbidden fruit, has long since passed; for science now is constantly developing wonders more incomprehensible than were the inventions of Guttenberg and Dr. Faustus in their time to their people.

To emphasize what I have said, stands out the fact that science to-day is practical. It is recognized by everybody. The most ignorant knows that science is the instrumentality that daily helps him to the joys of life; that daily adds to our convenience. It enters into everything that we do, into our food and our drink, and into the exercises and curriculum of our physical and mental training. It touches everything, from the cooking stove to the rose bud; from the machine shop to the trees in the forest; from the human stomach to the human soul.

There may possibly be in this universality of scientific training and scientific pursuits, which are essentially practical and material—there may be an unsolved problem as to the future effect upon life, thought and activity of the human intellect. It may so dominate the domain of thought and pursuits as to sidetrack, so to speak, and to place in the background, those things in human life and human culture which we are pleased to call the æsthetic side of our nature—poetry, art, and things of that kind. But that is a suggestion which is far too significant for me to attempt to pursue. We are here to recognize the qualities that science has everywhere unfolded.

I believe that very lately some one has claimed to have discovered the mystery of animal life and to be able to create it out of apparently lifeless matter. If that is accomplished, it will almost unlock the door which separates the finite from the infinite.

At this time, gentlemen of the American Association for the Advancement of Science, your presence here is specially welcome to the people to this city. There is an under touch of pathos in it, if you will permit me. Louisiana, the southern coast of your great country, has been for generations past under a constant cloud and pall of calamity. A mysterious disease which baffles not only human skill in treatment, but baffles human intellect, ingenuity and enquiry, both as to its coming and going, and its awful and desolating spread. But science has lifted that shadow from us, and we are able now to look the future in the face with confidence and hope. So that at this time, while we are still under the spell of that evil, yet, under the influence of the renewed hope your coming in our midst as scientists with one problem which you have proposed to yourselves to be that of investigation, realization and confirmation of the things so far developed—I say your coming to us is like manna in the wilderness, and it has, therefor, that touch of sympathy and to us here in New Orleans, your coming is doubly welcome.

I will not detain you long, but there are other things which we might refer to, not as matters of science, for I abstain from advice. I would not be able to tell you anything that you do not know much better than I; but coming together here, in almost the extreme southern point of our great land, we ought not and could not if we would, ignore the fact that we are compatriots, and that in your thus coming, there must be a sentiment of affection as well as of utility.

This, our great country, holds in its vast domains almost every characteristic of clime and nature found upon the globe, from the freezing north to the tropics of the south, and with a population in whose veins courses the blood of every civilized nation on earth; and it is one of our great problems, one that should engage the attention of scientists, political commissions, statesmen and every good citizen to see that by intercommunion and by law, we ought, above all things, to preserve the homogenity of that great population. They should center upon a spirit of national unity. They should realize that we have but one country, and that the whole country. (Applause.) But one welfare, and that the welfare of all the people. But one pride of citizenship, and that the same, whether it throbs from the plains of Chalmette or under the shadow of Bunker Hill.

So we are here to welcome you in these double capacities. I could say much to you of our good local people; of the famous and noted hospitality of our historic city, but I will not trespass upon the time of His Honour, the Mayor, who will welcome you on their behalf, in his own person. I will only say and add the idea that independent of the national sentiment, meetings of this character, of men whose souls are dedicated to noble

work, are bound to be sentimental in a social sense as well. Men cannot come together from far off sections, as you do, without arousing in your souls the ideals of better life, of better inter-communion and peace, unity and concord in our daily being. We are all made better for such things as these, for such inter-communion of souls and minds, and the interchange of ideas for the well-being of all.

And so we welcome you with a sentiment of brotherhood as well as with a sentiment of hospitality, and hope, in the name of the people of Louisiana, that your coming to us, doubly significant as it is,because you could probably have done your work nearer home than here, which confirms us in the belief that there is a sentiment that has brought you in our midst; that your deliberations may not only bring to you that glory, honor and success, after which you all strive, but that they may warm and keep alive in your hearts that sentiment of good fellowship and create a national brotherhood which shall inspire all the people of this great country. That you will take with you not only pleasant reminiscences of the success of your meeting, but as well of the welcome and good cheer with which our people greet you and of their sincere wishes for your future happiness and prosperity.

President WOODWARD: I am now permitted to introduce to you His Honor, the Mayor of the city of St. Louis (laughter)—of New Orleans, Hon. Martin Behrman. (Applause.)

Mayor BEHRMAN, on behalf of the city, spoke briefly in part as follows:

We have set out on a progressive march and are pressing forward to a great commercial development for the attainment of which we are equipping ourselves with every modern device and facility. Chief among these are our systems of sewerage and drainage,as well as one for a supply of pure and healthful water, all of which are now in course of construction, as will be evidenced in the torn-up and almost impassable condition of many of our thoroughfares. I have been informed that there are in your organization members who have made a special study of these undertakings. We most earnestly invite them to examine our work as far as it has been prosecuted. Arrangements have been made to facilitate them in this inspection. We want your suggestions and advice; we invite your criticism, knowing full well that anything you may have to say will proceed solely from your desire to insure our betterment and advancement.

I can assure you that our people appreciate highly the fact that among the great features of your deliberations in this convention is the section devoted to the discussion of these very subjects. We all feel that of the many important conventions which have been held in this city, this is really the most important. Its deliberations touch and treat upon so many subjects in which our people and our city are so vitally interested, that your discussions will be listened to or read eagerly and accepted as authoritative. We are pleased sincerely that you have come among us, and as the chief executive of the city I deem it an honor to extend to you a most cordial welcome.

President E. B. CRAIGHEAD, of Tulane University, extended a most friendly greeting to the visitors on behalf of the schools and colleges of New Orleans. He referred to the fact that here was located the first institution of learning for women established in this country, one hundred and fifty years ago—the Ursuline Convent. This was the home of John McDonough, who had made the largest bequest of any citizen to the public schools. It was also the home of Paul Tulane, who had made the largest bequest to Tulane University, formerly the University of Louisiana, but which took his name in honor of its benefactor. It was the home of A. C. Hutchinson, who had left $800,000 to the medical department of Tulane University. It was the home of Mrs. Dr. T. G. Richardson, who had given $150,000 to the medical department of Tulane. It was the home of Mrs. Josephine Louise Newcomb, who had left $3,500,000 to the Newcomb College, the woman's branch of Tulane University, which would be the best endowed college for women in the world. He welcomed the visitors to the home of such philanthropists and hoped their deliberations here would be fruitful of much good.

President WOODWARD: Mr. Buck, His Honor, the Mayor, and President Craighead, on behalf of the American Association for the Advancement of Science, I thank you for this cordial welcome to your city and to your state.

At Philadelphia, when the question came up as to where we should meet in December, 1905, there seemed to be but one voice. We must go to New Orleans. We have never met in that ancient, in that historic city, and so we are here, gentlemen, not all of us, but a very strong delegation of what I would say, if I were not a member myself, the cream of the Association. We number, I am told, 4,312 people devoted to the advancement of science. We represent every state in the Union, from the far East, the far North, the far West and the far South, and, indeed, all foreign lands, pretty much, on the face of the earth. We represent men devoted to the cultivation of science, and in all of our work I can truthfully say that, while we love science for science's sake, we also love it for the service which it does for humanity. We love it because we live by it, and this modern world of ours moves on largely through the influence of our scientific men.

I want to say that we are glad to be here. We are glad of this welcome. We are glad to respond to the sentiments that we all cherish in our hearts. We are proud of your record; of your noble men and women who have given of their means for the highest uses, and who have here erected on your soil the noblest monuments that could be built.

I am not unmindful of the history of this city and of this state. It has been brought to our attention again and again.

You rather suspect that I come from St. Louis (Laughter)—and we had abundant evidence there, about a year ago, of the activity and zeal of the people of New Orleans and of Louisiana. That historic building which we saw on the grounds at St. Louis, reminded us of that compact

by which we were originally a part of you, but here we are now, one of your sisters in this great valley.

Personally, I have been very much interested in two things connected with this city of New Orleans and of this region. It was my privilege to be an intimate friend of the great engineer who improved the possibilities of navigation on this great river, here at this point. Captain Eads and I together studied the problem and figured and theorized about the flow of water, the influence of jetties. I went all through the history of the improvement of South Pass, a few years ago, and am glad now to see great ships at your wharves that have come up out of the deep water of the Gulf of Mexico. That was the work of science. That was the principle of physics applied to this great river by that great engineer, the result of whose work has enabled us to control the mightest rivers and to understand the laws of nature so kindly and so inexorably forced upon us.

Again, I have been deeply pleased with the heroism displayed by the people of this great city, in your successful fight against the greatest of modern diseases, and our very presence here to-day shows the confidence with which we can come and live with you for a week, knowing that you have triumphed and that the yellow fever business is a matter of history merely, being no longer one of annoyance.

The gentleman speaking for the Governor of the State touched upon the question of sentiment. I feel it as deeply as any man can feel it. I visited this city something over two score years ago, and I am so glad to come again. So glad to be with you in the interest of peace, concord, harmony and good fellowship. We are compatriots, it is true.

A few years ago, it happened that I was riding to Washington, appointed by the Governor of Missouri to a convention which was to urge upon Congress the improvement of the great Mississippi river. My seat mate, a very fine gentleman, interesting and agreeable in every way, and I, who until then had been perfect strangers, fell into a little conversation. I discovered in those dark days, the 60's, he was on one side of the line and I was on the other, and we told a great many little stories of our experience during those memorable times, and I asked him: "Well," said I, "what was your idea of a Yankee in those days?" Then he told me what his idea of a Yankee was. It was'nt at all complimentary, and there wasn't anything in it that gave me a glow of pleasure, but after he had finished drawing the picture, I said: "Now look me square in the face. I am a full blooded Yankee. My ancestors fought at Bunker Hill, yours fought at Chalmette, but here we are, friends again, and we are the men who were on opposite sides of the line during the 60's." Said he: "If we had known each other then as we know each other now, we would not have shot each other down." And that is true. We are here to-day with the hand of good fellowship. With the hand of a compatriot. With the hand of fellow scientists to receive your welcome, expecting and asking you to join in our exercises. To listen, if you can, patiently, to our scientific papers. You are welcome to every meeting of

every department of the Association, and I am sure, as I walk your streets, and as I accept your hospitality in your homes and in the interesting places in this vicinity, I shall go back home with memories of a glorious city rising to a great future in this day for the one common cause of science devoted to the cause of civilization.

In conclusion he announced that everybody was welcome to all the meetings of the sections, and he hoped the people of New Orleans who were interested in science would attend.

The general secretary, C. A. Waldo, then read an invitation from the sewerage and water board to inspect the public works in progress in New Orleans, with the names of a committee of five to facilitate such an inspection.

A resolution presented by Dr. Wm. Trelease, director of the Missouri Botanical Gardens, which had been favorably acted on by the council at the session in the morning, was presented to the general session for action. It related to the efforts to save Niagara Falls from destruction, and endorsed the stand taken by President Roosevelt. The resolution was adopted unanimously.

The following committees were appointed to serve during the meeting:

Committee on new members: The permanent secretary and secretary of the council.

Committee on fellows: The general secretary and the vice-presidents of the sections, Mr. Waldo, Chairman.

Committee on grants: The treasurer and the vice-presidents of the sections, Mr. R. S. Woodward, Chairman. In the absence of Mr. Woodward, the permanent secretary served in his place.

Mr. Theodore N. Gill was chosen auditor of the association.

After the first session of the council in St. Charles Hotel, all others were held daily, except Sunday, at Tulane University at 9 o'clock, A. M. Two general sessions were held on the Friday and Wednesday following at 10 A. M. As in the previous year the vice-presidential addresses were scattered through the week.

REPORT OF COMMITTEES.

On the Study of Blind Invertebrates.

Mr. A. M. Banta continued his work on the fauna of Mayfield's Cave during last winter and through the entire summer. I have passed on his paper "Mayfield's Cave as a Unit of Environment and the Ecological Relation of its Inhabitants," which is now ready for the printer. It is a unique and comprehensive work on the fauna of this cave. The work was completed without calling on the appropriation made at the last meeting for the work of the committee.

It was the plan to have Mr. Banta visit the region in Pennsylvania where Professor Cope, years ago, secured his blind catfish which has not been found again. The finishing of his Mayfield Cave paper delayed

him so that he was not able to do this before going to Harvard University, where he holds a fellowship. He is at present at Harvard, working on the reactions of cave animals. Live specimens have been sent him from time to time.

Mr. Banta will visit How's Cave in Central New York during this week. This cave being in the glaciated region ought to have a much newer fauna than the Indiana, Kentucky and Missouri caves, all of which are south of the drift region.

For unavoidable reasons, I have not been able to go into the field myself. The entire appropriation made for this work at the last meeting of the association is available for the future work of your committee.

Respectfully submitted,

(Signed) C. H. EIGENMANN,

Recorder.

REPORT OF COMMITTEE ON ELECTROCHEMISTRY.

A study has been made of the behavior of platinum and iridium in chlorine water and in dilute hydrochloric acid. Smooth platinum foil brought about no evolution of gas, even after standing 168 hours in chlorine water. Under precisely similar circumstances an iridium foil caused an evolution of 44.4 of gas, 55 per cent. of which was oxygen. The oxygen results from the reaction

$$Cl_2 + H_2O = 2HCl + O,$$

while the chlorine came from the solution, the original vapor pressure having been about half an atmosphere. This series of experiments showed that iridium was a more powerful catalytic agent than platinum. A number of electrolytic experiments were made with hydrochloric acid of different concentrations. In all cases more oxygen was evolved from the iridum anode than from the platinum anode. The question as to the final equilibrium is still in doubt.

It was hoped that a tantalum anode could be secured for this work, but this proved impossible and the money appropriated for the year 1905 was not drawn from the treasury. The committee asks that this unexpended balance be left available for the coming fiscal year.

WILDER D. BANCROFT,
EDGAR F. SMITH,
L. KAHLENBERG.

Verbal reports of progress were made by the committees on "The Relation of Plants to Climate," and of "Anthropometric Measurements."

GRANTS.

$200 were allotted by the committee on grants to Messrs. Parson's Kinnicutt and Venable to assist in the publication of Professor Parson's "Bibliography of Beryllium."

$100 were allotted to "The Concillium Bibliographicum Zoologicum."

RESOLUTIONS.

Preservation of Niagara Falls.

As has been well said by President Roosevelt in his message to the fifty-ninth Congress, "There are certain mighty natural features of our land which should be preserved in perpetuity for our children and our children's children." Chief among these natural wonders in the east is Niagara Falls, the continuance of which as a scenic feature is now seriously threatened by the use of the water for the production of electric power. Authorities agree that grants to existing corporations for power purposes will, when the now rapidly proceeding work of development is completed, entirely destroy the American fall, also making useless the magnificent New York State Reservation which has so well preserved the natural beauty of the cataract's surroundings.

President Roosevelt further suggests that if the state of New York can not promptly take action to avert this impending calamity, "she should be willing to turn it over to the national government, which should in such case (if possible, in conjunction with the Canadian government) assume the burden and responsibility of preserving unharmed Niagara Falls." Therefore be it

Resolved, That the American Association for the Advancement of Science hereby records its hearty concurrence in these suggestions of President Roosevelt, and instructs its president and secretary to communicate to the President of the Senate, and to the Speaker of the House of Representatives of the United States its strong conviction that Niagara Falls should be preserved as a natural wonder, and further expressing the earnest hope that the Congress now in session will take prompt and energetic action looking toward an international consideration of the impending danger to Niagara Falls. And further, be it

Resolved, That each member of the American Association for the Advancement of Science is hereby urged to write to the senators and congressmen of his own state, earnestly favoring immediate action for the preservation of Niagara Falls.

An Appalachian Forest Reserve.

Resolved, That the American Association for the Advancement of Science, now in session at the city of New Orleans, again respectfully calls attention to the rapid rate at which the forests of the Appalachian mountain region are being destroyed, and to the fact that, as a result of such destruction, the streams tributary to the Mississippi, as well as those flowing into the south Atlantic, are becoming continuously more irregular in their flow, and hence of less value for navigation and power purposes.

Resolved, That the association, therefore, respectfully petitions the Congress of the United States to make such provision as may be necessary for the protection of these mountain forests, and directs that copies

of these resolutions be transmitted to the Honorable, the Secretary of Agriculture, and to the Honorable, the Speaker of the House of Representatives.

The above resolution was unanimously approved by Section G, American Association for the Advancement of Science, at the meeting of December 30, 1905, also reported recommended by Section I.

AMENDMENTS.

The following amendments to the constitution were proposed and are to be acted upon at the New York meeting, having been duly read at the last general meeting session of the New Orleans meeting:

1. Add the words "and Psychology" to the name of section H, making it read "Anthropology and Psychology."

2. Add a new section to be called Section L—Education.

POLICY OF THE ASSOCIATION.

In accordance with the resolution adopted by the last Philadelphia meeting, through which a number of national scientific societies were accepted as having qualifications for membership equal to the qualifications for fellowship in the American Association, several hundred members from these societies were in the usual way made members of the American Association, were then nominated for fellowship and were elected by the council.

The committee on policy presented the following resolutions which were adopted by the council:

1. *Resolved*, That the terms of office of all officers of the association shall begin with the close of the meeting at which the elections take place.

2. *Resolved*, That the position of second assistant to the permanent secretary be abolished at the close of the year 1906.

3. *Resolved*, That an invitation be extended to the National Association for the Scientific Study of Education to affiliate with the American Association on the same terms as other affiliated societies.

CLOSING GENERAL SESSION 10 A. M. WEDNESDAY.

The report of the general secretary was read. Resolutions of thanks and appreciation unanimously adopted as follows:

Resolved, That the appreciative thanks of the American Association for the Advancement of Science be, and they are, hereby extended:

1. To President Craighead and the board of trustees of Tulane University for the provision of ample and adequate meeting places for most of the sections in the University buildings; further to Dr. Chaille and Dr. Metz for the excellent provision made for the Section of Physiology and Experimental Medicine in the medical school of the university; to the board of

trade for the use of its building, granted to the Section of Social and Economic Science through the interest of Secretary Mayo, of the New Orleans Progressive Union; to Rabbi Heller and the Congregation of Temple Sinai for the use of that building for the opening session, and to Professor Dixon for having the auditorium of the H. Sophie Newcomb College opened for the address of the retiring president of the association and other purposes.

2. To Professors Creighton and Anderson and their associates in the committee on meeting places and equipment for their provision of appliances, lantern service and other necessaries for the meetings.

3. To the sewerage and water board for enabling the Section of Mechanical Science and Engineering to inspect the sanitary improvements now under way in the city; to the officials of the United States Navy Yard for courtesies shown to the same section; to the dock commissioners for exhibiting the shipping facilities of the port to the Section of Social and Economic Science; to Mr. Charles Farwell and Dr. Dyer for a demonstration of the workings of the large sugar estate of the former; and to Professor Blouin and Dr. Brown for having the further privilege accorded the visiting chemists and others to inspect the Kenilworth Sugar Plantation.

4. To the Boston Club, the Pickwick Club, the Chess, Checkers and Whist Club, and the Young Men's Gymnastic Club, the Country Club and the Round Table Club, for extending the privileges of their houses to all members of the association.

5. To the Round Table Club for a general smoker; to the Louisiana Society of Naturalists for an informal reception given to the visiting botanists and zoologists; to Mrs. T. G. Richardson, whose home was hospitably opened; and to the many other citizens of New Orleans and its vicinity whose welcome was so admirably expressed by Mr. Buck on behalf of the governor of the state, by Mayor Behrman and President Craighead; and who, in one way or another, have made our visit pleasurable, without interfering with the more serious purposes of the association and affiliated bodies.

6. To the very efficient press committee and representatives of the newspapers, who have treated our proceedings with unusual interest, intelligence and care, thus furthering the general purposes of the association, and at the same time promoting local interest in pure and applied science.

Finally, and in the most comprehensive sense, to the local committee and especially to its presidents, Drs. Craighead and Beyer; its secretary, Mr. Mayo, and the chairman of its finance committee, Mr. Godchaux—in addition to the courtesies already mentioned—for providing ideal lunch arrangements, so convenient to the meeting places as to avoid a wasteful break in the day's work; for tendering a delightful reception—the peculiar charm of which was due in large part to the tactful management of Miss Minor and her associates in the ladies' reception committee; for a final ride, enabling us to carry away a coherent impression of New Orleans and its many points of historic interest; and for many acts of

thoughtfulness—individual as well as collective—that will cause the past week to remain among the most pleasant memories that cluster about the many pleasant meetings of the association.

(Signed) WILLIAM TRELEASE, *Chairman*,
For the Committee,
Messrs. Trelease, Magie and Newcomb.

Response to these resolutions and farewell were given for the local committee by Professor Geo. E. Beyer, who extended a cordial invitation to the association to meet soon again in New Orleans. Response by President Woodward, who was also formally thanked by the association for his efficient and acceptable work as presiding officer. Adjourned.

GENERAL COMMITTEE.

At the meeting of the general committee on Monday evening, January 1, 1906, it was decided to hold a special summer meeting at Ithaca, New York, to close on or before July 3, 1906, and a regular winter meeting in New York City to begin on Thursday, December 27, 1906. The presidential and vice-presidential addresses will be omitted at the summer meeting and given at the winter meeting.

The officers elected at the New Orleans meeting will, therefore, hold over to the close of the New York meeting. Chicago was recommended as the place of the winter meeting of 1907.

The following officers were elected for the Ithaca and New York meetings:

President: Dr. W. H. Welch, Baltimore, Md.
Vice-Presidents:
Section A—Dr. Edward Kasner, New York City.
Section B—Professor W. C. Sabine, Cambridge, Mass.
Section C—Mr. Clifford Richardson, New York City.
Section D—Mr. W. R. Warner, Cleveland, O.
Section E—Professor A. C. Lane, Lansing, Mich.
Section F.—Professor E. G. Conklin, Philadelphia, Pa.
Section G—Dr. D. T. MacDougall, Washington, D. C.
Section H—Professor Hugo Münsterberg, Cambridge, Mass.
Section I—Mr. Chas. A. Conant, New York City.
Section K—Dr. Simon Flexner, New York City.
General Secretary: Mr. John F. Hayford, Washington, D. C.
Secretary of Council: President F. W. McNair, Houghton, Mich.

CLARENCE A. WALDO,
General Secretary.

Report of the Treasurer.

In compliance with Article 15 of the Constitution, and by direction of the Council, I have the honor to submit the following report, showing receipts, disbursements and disposition of funds of the Association for the year ending December 31, 1905.

Receipts have come into the keeping of the Treasurer from three sources, namely, from life membership commutations, from return of grant made to Committee on Velocity of Light in 1904,* and from interest on funds deposited in savings banks and with the U. S. Trust Company. The total amount received from the first two sources is $575.00. The total amount received as interest on invested funds is $511.83.

Disbursements made in accordance with the directions of the Council amount to $350.00.

The total amount of funds of the Association deposited in savings banks and with the U. S. Trust Company, and subject to the order of the Treasurer, December 31, 1905, is $16,191.90.

The details of receipts, disbursements, and disposition of funds are shown in the following itemized statement.

Dated April 15, 1906.

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*The full amount of the grant ($75.00) was returned by the estate of Professor D. B. Brace, deceased.

THE TREASURER IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1905.	DR.		
Jan. 1.	To balance from last account		$15,455.07
Apr. 4.	To 10 life membership commutations		500.00
Nov. 17.	To amount of grant returned from Committee on Velocity of Light		75.00
Dec. 31.	To amount of interest received from funds deposited in banks, as follows:		
	From Cambridge Savings Bank, Cambridge, Mass.	$36.97	
	From Emigrant Industrial Savings Bank, New York, N. Y.	117.52	
	From Metropolitan Savings Bank, New York, N. Y.	102.51	
	From Union Square Savings Bank,* New York, N. Y.	101.39	
	From U. S. Trust Company, New York, N. Y.	153.44	
			511.83
	Total		$16,541.90

*Hitherto known as Institution for the Savings of Merchants' Clerks.

THE TREASURER IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

1905.	Cr.		
Mar. 9.	By grants (of 1903 and 1905) paid to the Concilium Bibliographicum		$200.00
Sept. 16.	By grant paid C. H. Eigenmann of Committee on Cave Faunea		100.00
Oct. 30.	By grant paid William H. Dall for republication Museum Boltenianum		50.00
Dec. 31.	By cash on deposit in Banks, as follows:		
	In Cambridge Savings Bank, Cambridge, Mass.	$1,084.89	
	In Emigrant Industrial Savings Bank, New York, N. Y.	3,026.72	
	In Metropolitan Savings Bank, New York, N. Y.	2,908.94	
	In Union Square Savings Bank, New York, N. Y.	2,872.84	
	In U. S. Trust Company, New York, N. Y.	6,153.44	
	In the Fifth Avenue Bank of New York, N. Y.	145.07	
			16,191.90
	Total		$16,541.90

I hereby certify that the foregoing account is correctly cast and properly vouched.

THEO. GILL,
Auditor.

REPORT OF THE PERMANENT SECRETARY.

The matters heretofore referred to in the report of the Permanent Secretary, in so far as they relate to the annual meeting, have been covered in the report of the executive proceedings prepared by the General Secretary, and duplication is avoided by omitting them under the present head.

The following is a comparative statement of the roll of members as printed in the St. Louis and Philadelphia volumes and in the present volume:

	St. Louis.	*Philadelphia.*	*New Orleans.*
Surviving founders	3	2	2
Living patrons	2	2	2
Living honorary fellows	3	3	3
Fellows	1,255	1,351	1,864
Members	2,864	2,903	2,486
Totals	4,127	4,321	4,357
Honorary fellows life (founders) included in the above	3	3	2

L. O. HOWARD,
Permanent Secretary.

L. O. HOWARD, PERMANENT SECRETARY, IN
TION FOR THE ADVANCE-

From January 1, 1905, *to*

	Dr.	
To balance from last account		$11,886.13
Admission fees	$2,365.00	
Annual dues for 1905	4,316.00	
Annual dues for 1906	7,742.00	
Annual dues for previous years	309.00	
Associate fees	57.00	
Life membership fees	297.00	
		15,086.00
Publications	4.89	
Binding	5.50	
Miscellaneous receipts	3.12	
Interest	93.03	
		106.54
		$27,078.67

ACCOUNT WITH THE AMERICAN ASSOCIAMENT OF SCIENCE.

January 5, 1906.

	Cr.	
By publications.		
To publishers SCIENCE	$7,571.66	
On acct. Vol. 53	1,247.25	
Philadelphia pamphlet and authors' extras	232.60	
		$9,051 51
By expenses Philadelphia and New Orleans meetings.		
Secretaries of sections	667.84	
Badges	37.72	
Stenographers and other expenses	85.56	
Press Secretary	100.00	
Philadelphia program	400.00	
		1,291 12
By general expenses, including propaganda.		
Postage	482.20	
Express	13.84	
Telegrams	23.14	
Extra clerical help	148.85	
Printing circulars, forms, stationery, electrotypes, office supplies, etc	375.63	
		1,043.66
By salaries.		
Permanent Secretary	1,500.00	
Assistant Secretary	750.00	
Assistant Secretary	200.00	
		2,450.00
By miscellaneous disbursements.		
To Treasurer	500.00	
Overpaid dues returned	6.00	
		506.00
By balance to new account		12,736.38
		$27,078.67

I hereby certify that the foregoing account, as of January 5, 1906, has been examined and found correct, and that proper vouchers for the expenditures have been exhibited. The balance of $12,736.38 was on deposit in the following Washington D. C. depositories:

National Safe Deposit, Savings & Trust Co.....	$1,626.52	
American Security & Trust Co.....	2,833.12	
American National Bank.....	8,275.69	
Metropolitan-Citizens' National Bank.....	1.05	
		$12,736.38

THEO. N. GILL,
Auditor.

INDEX.

INDEX.

PAGE.

Abelian subgroups $H_{p^{n}}$ of Type $[n, n, \cdots, n]$: On the groups of Order $p^{n}q$ having 249
Abbott, Alexander C., Introductory remarks at symposium on yellow fever and other insect-borne diseases 507
Absorption, Molecular 316
of atmospheric moisture by desert shrubs . . . 441
phosphate by soils 316
potassium by soils 317
Accounting and auditing, Economic aspects of 487
Acid, Citric 318
hydrocyanic, in Cossava, The estimation of 319
phosphoric, of the soil, Availability of 318
salicylic, The quantitative estimation of 319
Act of incorporation 28
Action of eosin and erythrosin upon snake venom 329
upon tetanus toxin and in tetanus 329
Activity of the white rat at different ages 411
Address by retiring president 213
Aestivo-autumnal fever --Cause, diagnosis, treatment and destruction of mosquitoes which spread the disease . . . 507, 537
Affiliated societies 544
Affinities of the fungus of Lolium temulentum 442
Agaricus campestri, The development of; The development of Armillaria mellea 439
Agricultural and sanitary chemistry 318
chemistry, Some important problems in 313
Agriculture, Teaching in rural schools 473
in Texas, Some problems of 474
Alcohol, The effect of on the secretion of bile 330
Alcoholic solutions, The heat of dilution of resorcinol in . . 336
Alloys, The antimony-tin 314
Alternating current, A device for producing an instantaneous arc at any phase of an 288
Aluminium compounds, The influence of on lupin seedlings . 328
pheonolate 333
Amendments, Report of Committee on 553
America, Latin, Our commercial relations with 492
American chemist and the gas industry 322
mycological society, papers presented 442
species of Lumbriculus Grube, An 410

PAGE
Amido bodies, The separation of preoteoses and peptones from the simpler 325
Ammonia, Ethyl oxomalonate and its behavior toward . . 333
Ammonium sulphate, The solubility of gypsum in solutions of . 336
Amorphous sulphur 314
Amyloid and mucoid. On the biological relationship of nucleo-proteid and 330
Animal tissues, On the decomposition of purine bodies by . . 330
Animals, Experiment to determine the effects of radium on minute 326
Anthropology 445
Anticlinal, On the Jackson, in Clarke county, Ala. 376
Anticlinorium, On the use of the words synclinorium and . . 375
Antimony-tin alloys 314
Appalachian forest reserve, Report of a Committee on an . . 552
Arc, instantaneous, A device for producing an at any phase of an alternating current 288
Armillaria mellea, The development of; The development of Agoricus ampestri 439
Arthrodires, Dipnoan affinities of 379
Arthur, J. C., Paper by 442
and F. D. Kern, Paper by 440
Artificial coloring matter in whiskey 320
cultures, Ring formation in 440
Ascidia in Fraxinus 438
Association of American geologists and naturalists, Meetings of
Astronomy, Mathematics and 235
Atkinson, Edward, Paper by 489
Geo. F., Paper by 439
J. P. and H. Durand, Paper by 333
Atmospheric moisture, Absorption of, by desert shrubs . . 441
Auditing, Economic aspects of accounting and 487
Auditor. 550
Availability of the phosphoric acid of the soil 318
Avery, L., Paper by 321
Bailey, E. H. S., Paper by 321
E. M., and L. B. Mendel, Paper by 328
Baker, R. H., and David Todd, Paper by 252
Baldwin, J. A., Paper by 475
Banana, Studies on the 328
Bancroft, W. D., Papers by 314, 324
Barbour, Erwin H., Paper by 378
Barometric pressure and carbon dioxide, The relation between . 324
Beatty, W. A., and P. A. Levene, Paper by 330
Behavior of the pollen tube in Houstonia Cærulea . . . 440
Behrman, Hon. Martin, Remarks by 547
Bell, J. M., and F. K. Cameron, Papers by 316, 336
and W. C. Taber, Paper by 336

PAGE
Bement, E., Paper by 322
Benedict, F. G., Paper by 328
Benton, J. R., Paper by 292
Berg, W. N., Paper by 331
and W. H. Welker, Paper by 327
Bigelow, W. D., and F. C. Cook, Paper by 325
W. L. Dubois, Paper by 319
H. C. Gore, Paper by 320
H. C. Gore, and B. J. Howard, Paper by . . 320
Bile, The effect of alcohol on the secretion of 330
Billings, F. H., Paper by 437
Biological chemistry 324
relationship of nucleoproteid, amyloid and mucoid . 330
Bitumen, total soluble, Comparison of methods used in determining in paving material 321
Blackshear, E. L., Paper by 476
Blind invertebrates, Report of the committee on the study of . 550
Body weight, Relation of carbon dioxide excretion to . . 324
Bolce, Harold, Paper by 492
Botany 415
Bothriocephalid parasite of man, A new 410
Brachiopods, Old age in 379
Braunstein, methods for determining urea; The influence of salicylic acid on the excretion of urea and uric acid, and a comparison of the Mörner-Sjiqvös. 325
Bridge, The percentage 293
Brown, F. C., Paper by 291
Browne, C. A., Jr., Paper by 319
Brownlee, R. H., and Alexander Smith, Paper by 314
Buck, Chas. F., Remarks by 544
By-products of the cane-sugar and rice mills, Utilization of the . 474
Cody, H. P., and D. F. McFarlane, Paper by 334
Cain, J. R., Paper by 322
Calkins, Gary R., Paper by 507
Cameron, F. K., and J. M. Bell, Papers by 316, 336
B. E. Livingston, Papers by 316, 319
Canal, Panama, A sea-level 294
Observations on 353
Cane-sugar and rice mills, Utilization of the by-products of the . 474
Carbamates, Contributions to our knowledge of the chemistry of . 330
Carbon dioxide, Relation between barometric pressure and . 324
excretion, Relation of to body weight . . 324
Carroll, James, Papers by 507, 530
Discussion of G. N. Calkins' paper, Protozoan life-cycle 511

PAGE

Carroll, James, Papers by
Discussion of Quitman Kohnke's paper, Difficulties of recognition and prevention of yellow fever . 522
Casein, salts of, Investigation on 324
Cassava, Estimation of hydrocyanic gas in 319
Cattle, A Mendelian character in 410
Cement plaster, The durability of 321
Census, The twelfth, of manufactures 490
returns on manufactures 489
Chemical combination, The thermochemistry of 315
composition of the hair of different races, The comparative 332
nasal mucous membrane . . 332
Chemist, The American and the gas industry 322
Chemistry 295
agricultural, Some important problems in . . 313
and sanitary 318
Biological 324
Industrial 321
Organic and inorganic 332
Physical 314, 335
Child-labor problem: A study in degeneracy 484
Chloral, Diphenylamine compounds of 333
Chlor-hydrochlorides of pinene and firpene 333
Circulation, poor, in a boiler, Priming caused by . . . 293, 351
Citric acid 318
Civic improvement, Relation of schools to 475
Civilization, Why advancing, in America, increases crime; Some methods of relief 485
Class of central forces 250
Classification of the flowering plants, The generic concept in the . 417
Uredinales, Some reasons for desiring a better . 442
Climate, Effect of on the composition of cotton seed . . . 319
Clowes, G. H., Paper by 325
Clubs, Social work of the General Federation of Women's . . 478
Coal, Note on sampling and analysis of 322
Coates, C. E., Paper by 332
College, an engineering, Investigations and commercial tests in connection with the work of 339
Colletotrichum and Glæosporium, Cultures of 442
Coloring matter, The artificial in whiskey 320
Colquitt, O. B., Paper by 479
Combination, Transportation and 459
Commercial relations with Latin America, Our 492

PAGE
Committee on amendments, Report of 553
an Appalachian forest reserve, Report of . . 552
electro chemistry, Report of 551
fellows 550
grants 550,551
Report of 551
new members 550
policy of the Association, Report of . . . 553
resolutions 552
the study of blind invertebrates, Report of . . 550
general, Meeting of 555
Comparative chemical composition of the hair of different races . 332
Comparison of methods used in determining total soluble bitumen in paving material 321
Composition of petroleum from American fields, Pennsylvania, Ohio, Texas, Kansas, Wyoming, Colorado, Kentucky and California 322
Computed traces and totality-durations of the total solar eclipses of the twentieth century 252
Concerning peptone 331
Constitution 29
Contributions to our knowledge of the chemistry of carbamates . 330
Cook, A. N., Paper by 333
F. C., and W. D. Bigelow, Paper by 325
Mel. T., Papers by 409, 440
Copper in water, A method for the determination of small amounts of 318
salts in irrigation waters, A trade waste supply . . 318
Correlation between ovules and matured seeds in leguminous fruits 441
Corymorpha, The embryology of 412
Cotton-mill workers, Southern, Their condition and needs . . 475
oil industry of the South 321
seed, Effect of climate on the composition of . . . 319
warehousing from the producers' standpoint, Possibilities of 471
Craighead, E. B., Remarks by 548
Cressy, C. R., and G. B. Frankforter, Paper by 333
Crew, Henry, Paper by 288
Crime, Why advancing civilization in America increases, Some methods for relief 485
Critical analysis of method of supplying power to branch telephone exchanges on the common battery 289, 350
Cronartium quercum, (Berkelay), Peridermium cerebrum Peck and 442
Crowell, John Franklin, Secretary of Section I, Report . . 493
Crystals, Elastic after-effects in 292
Cultures, Artificial, Ring formation in 440
of Colletotrichum and Glæosporium 442

PAGE
Cupric oxide, Note on the action of hot on sulphuric ether . . 333
Currency reform and postal savings system 490
Current, alternating, A device for producing an instantaneous arc at any phase of an 288
Curtiss, R. S., Paper by 333
Cushman, A. S., Paper by 318
Cutaneous excretion of nitrogenous material 328
Cyanides, complex, Action of metal on, in aqueous solution . 318
Cyclic subgroups of order p^a, The groups of order p^m which contain exactly p 251
Cytological changes accompanying secretion in nectar glands of Vicia faba, Structure and 442
Date endosperm, Incapacity of for self-digestion 328
Death Gulch, Yellowstone National Park, Report on the water of 334
Deceased members 208
Decomposition of purine bodies by animal tissues 330
thymus nucleic acid by an extract of pig's spleen 331
Degeneracy, A study in: The child-labor problem, ... 484
Race 486
Degree, Dual, for engineering courses 293, 351
Description of improved apparatus and of a modification of Drehschmidt's method for the determination of sulphur in illuminating gas 322
Descriptions of a new genus and nine new species of Sphæromidæ . 411
Desert shrubs, Absorption of atmospheric moisture by . . . 441
Development of Armillaria mellea; The development of Agoricus ampestri 439
Deviation, easterly, beneath the earth's surface, An experiment on 287, 349
Device for producing an instantaneous arc at any phase of an alternating current 288
Difference in the coefficient of discharge of steam through a single orifice and through a number of orifices near each other . . 290
through a single circular orifice, and through a number of circular orifices in the same plate 350
Digestion, tryptic, The relation between the concentration of hydroxyl ions and the rate of, in dilute solutions of various bases . 331
Diphenylamine compounds of chloral 333
Dipnoan affinities of arthrodires 379
Diseases, Filariasis and trypanosome 507, 511
Dodson, W. R., Paper by 474
Dogs, The effects of intravenous injection of radium bromide in . 372
radioactivity of the organs of after administration of radium bromide 327
Dowd, Jerome, Paper by 486

PAGE
Doyle, A. M., Paper by 322
Drehschmidt's method for the determination of sulphur in illuminating gas ,A description of improved apparatus and of a modification of 322
Dual degree for engineering courses 293, 351
Dubois, W. L., and W. D. Bigelow, Paper by 319
Ducktown, Tennessee, Erosion at 377
Durability of cement plaster 321
Durand, H., and J. P. Atkinson, Paper by 333
Earle, F. S., Paper by 442
Eastman, C. R., Paper by 379
Eclipse, total solar, of 1905, Observations of the, August 30, at Tripoli, Barbary 251
Eclipses, total solar, of the twentieth century, Computed traces and totality-durations of 252
Economic aspects of accounting and auditing 487
development of the South, The relation of higher education to 473
Edgerton, Charles E., Paper by 478
Education, Public, in Texas 471
Relation of higher to the economic development of the South 473
Effect of alcohol on the secretion of bile 330
climate on the composition of cotton seed 319
rays of radium on plants 326
Effects of intravenous injection of radium bromide in dogs . . 327
Elastic after-effects in crystals 292
Electrochemistry, Report of committee on 551
Electrolysis and endosmosis in the study of rock decomposition . 318
Endosmosis, Electrolysis and, in the study of rock decomposition 318
Elliptic functions, A chapter in the present state of development of 249
Embryology of Corymorpha 412
the Nympheacæ, Notes on the Morphology and . 440
Emerson, Julia A., and W. H. Welker. Paper by 331
Energy, The partition of 257
Engineering, Mechanical science and 337
college, Investigations and commercial tests in connection with the work of an 339
courses, Dual degree for 293, 351
Envelopes, Possible extension of the theory of 252
Eosin, The action of upon tetanus toxin and in tetanus . . 329
and erythrosin, The action of upon snake venom . . 329
Erosion at Ducktown, Tennessee 377
Erythrosin, The action of eosin and, upon snake venom . . 329

PAGE
Estimation of hydrocyanic acid in Cassava 319
Ether, sulphuric, Note on the action of hot cupric oxide on . . 333
drift, Report of progress in experiments on . . . 289
Ethoxydibromphenanthrenes, Methoxy-and, and some of their isomers 333
Ethyl oxomalonate and its behavior toward ammonia . . 333
European immigration, The restriction of 482
Everglades, The 439
Evolution of the higher vertebrates, Is mutation a factor in the . 383
Excretion of nitrogenous material. The cutaneous . . . 328
Executive proceedings 543
Experiment on easterly deviation beneath the earth's surface . 287, 349
Experimental method in sanitary science and sanitary administration. 497, 507
Experiments to determine the effects of radium on minute animals 326
influence of radium bromide on protein metabolism in dogs . . 327
Extraction of tanning materials for analysis 320
Failyer, G. H., and Oswald Schreiner. Papers by . . 316, 317
Farlow, W. G., Address by 213
Paper by 443
Feagin, N. B., Paper by 485
Fellows, Committee on 550
Fermentation of sugar-cane products 319
Fever, Aestivo-autumnal. cause, diagnosis, treatment and destruction of mosquitoes which spread the disease . 507, 537
yellow, Difficulties of recognition and prevention . 507, 517
transmission, The practical results of Reed's findings on 507, 513
and other insect-borne diseases, Symposium on . 507
Without mosquitoes there can be no . . 507, 530
Filaria loa, a study on the dispersal of parasites 409
Filariasis and trypanosome diseases 507, 511
Filtration and purification of the Mississippi river water at New Orleans 318
Fink, Bruce, Paper by 442
Fishes, Relations between the nerves of taste and touch in . . 412
The physiological effects of changes in water density and salinity, on 411
Flexner, S., and H. Noguchi, Paper by 329
Florida, North central. Some sink-hole lakes of 378
Phytogeography of 439
strand 439
Flowering plants, The generic concept in the classification of the . 417
Fluorescence spectra. Note on the distribution of energy in . 290

PAGE
Forces, A class of central 250
Forest reserve, Appalachian, Report of Committee on an . . 552
Forestry, Relations of to soil and climate 471
Fouquieria splendens and verbena ciliata, Stomatal action and transpiration in 441
Frankforter, G. B., Paper by 334
and C. R. Cressy. Paper by . . . 333
F. G. Frary, Paper by 333
E. P. Harding, Paper by . . . 322
Fraps, G. S., Papers by 318, 319, 474
Frary, F. G., and G. B. Frankforter, Paper by 333
Fraxinus, Ascidia in 438
Freeman, E. M., Paper by 442
Frequency meter, A new type of 289, 349
Fungi, North American gill, ... 442
new to America, Some peculiar 443
Fungus of Lolium temulentum, The affinities of the . . . 442
Fusoma parasiticum Tubuef, The occurrence of in this country . 443
Gager, C. S., Paper by 326
Gas, illuminating, A description of improved apparatus and of a modification of Drehschmidt's method for the determination of sulphur in 322
natural, On the occurrence of helium in 334
industry, The American chemist and the 322
pressure, Distribution of in a closed tube rotating on a transverse axis 288
General Committee, Meeting of 555
secretary, Report of 543
Generic concept in the classification of the flowering plants . . 417
Geography, Geology and 355
Geology, Hydrology and, of the Gulf embayment area of west Tennessee, west Kentucky and southern Illinois . . 377
and geography 355
Geometry, A new straight in the non-Euclidean . . . 249
Gies, Wm. J., and H. D. House, Paper by 328
B. Russell, Paper by 332
Gill, Theodore N., Auditor 550
Gill fungi, North American 442
Glæosporium, Cultures of Colletotricum and 442
Glenn, L. C., Papers by, ... 377
O. F., Paper by 249
Gore, H. C., and W. D. Bigelow, Paper by 320
W. D. Bigelow, and B. J. Howard, Paper by . . . 320
Granger, Mrs. A. O., Paper by 478
Grants, Committee on 550, 551

PAGE
Grapes, Improvement of the quality of 437
Great catalogue of the Heber R. Bishop collection of jade . . 380
Growth and ripening of persimmons 320
Gulf region of the United States, On some post-eocene and other formations of the 357
states, Uredineæ of the 442
Gypsum, The solubility of in solutions of ammonium sulphate . 336
magnesium sulphate . 336
Hair, of different races. The comparative chemical composition of 332
Halstead, G. B., Paper by 249
Hancock, Harris, Paper by 249
Harding, E. P. Paper by 322
and G. B. Frankforter, Paper by . . . 322
Harris, J. A., Paper by 441
Harrop, H. B., Paper by 322
Hoskins, H. D., and J. J. R. Macleod, Paper by 330
Hawk, P. B., and T. A. Rutherford, Paper by 332
Heber R. Bishop collection of jade, The great catalogue of . . 380
Hedgecock, George C., Paper by 440
Hedrick, H. B., Paper by 250
Helium in natural gas, On the occurrence of 334
Herrick, C. Judson, Paper by 412
High school, public, The social service of, in the South . . . 491
Higley, G. O., Papers by 324
Honorary fellows 40
Honest, safe and economical life insurance 488
Hough, Walter, Address by 447
House, H. D., and Wm. J. Gies, Paper by 328
Houstonia cærula, The behavior of the pollen tube in . . . 440
Howard, B. J., H. C. Gore, and W. D. Bigelow, Paper by . . 320
Hurt, H. H., and F. P. Veitch, Papers by 320
Hussakof, L., Paper by 326
Hydrocarbons in Louisiana petroleum, Some 322
Hydrocyanic acid in Cassava, The estimation of . . . 319
Hydrology and geology of the Gulf embayment area of west Tennessee, west Kentucky and southern Illinois . . . 377
Hydroxyl ions, The relation between the concentration of and the rate of tryptic digestion in dilute solutions of various bases . 331
Ibervillea sonoræ, on the composition and toxic properties of . 331
Immigration, Methods of developing traffic, industry and, by a modern railway 481
The restriction of European 482
Improvement of the quality of grapes 437
Incapacity of the date endosperm for self-digestion . . . 328
Incorporation, Act of 28

PAGE
Incorporated scientific bodies 207
Industrial chemistry 321
training and the negro problem in the United States . 476
Influence of aluminum compounds on the growth of lupin seedlings . 328
salicylic acid on the excretion of urea and uric acid, and a comparison of the Mörner Sjiqvöst and Braunstein methods for determining urea 325
Inks, writing, The examination of 322
Insect phylogeny, The problem of wing origin and its significance in 412
Insurance, life, Honest, safe and economical 488
Intravenous injection of radium bromide in dogs, The effects of . 327
Inversion and inversors 251
Invertebrates, blind, Report of committee on the study of . . 550
Investigation on salts of casein 324
Investigations and commercial tests in connection with the work of an engineering college 339
Iron and steel, Standard sample of 322
Is mutation a factor in the evolution of the higher vertebrates? . 383
Ithaca Meeting, Council for 12
Officers for 10, 555
Jackson, F. G., and T. W. Richards, Paper by 335
anticlinal in Clarke county, Ala., On the 376
Jacobus, D. S., Papers by 290, 293, 339, 350, 351
Jade, The great catalogue of the Heber R. Bishop, Collection of . 380
Jews in Russia, Their economic and social position . . . 483
Jones, Walter, Paper by 331
Kasner, Edward, Paper by 250
Kathlenberg, Louis, Paper by 315
Kern, F. D., and J. C. Arthur, Paper by 440
Keweenawan at Lake of the Woods in Minnesota . . . 378
Kinnicutt, Leonard P., Paper by 297
Kinsley, Karl, Papers by 289, 350
Kirkland, J. H., Papers by 473
Knapp, Martin A., Address by 459
Knight, N., Papers by 334
Knipp, Charles T., Paper by 289
Kohnke, Quitman, Papers by 507, 517
Kortright, F. L., Papers by 318, 334
Kunz, G. F., Paper by 380
Lafrentz, F. W., Paper by 487
Lake of the Woods Minnesota, The Keweenawan at . . . 378
Langsdorf, A. S., Papers by 289, 349
Latin America, Our commercial relations with 492
Lazenby, W. R., Paper by 471

PAGE
Lefevre, Arthur, Paper by 471
Leguminous fruits, Correlation between ovules and matured seeds in 441
Levene, P. A., and W. A. Beatty, Paper by 330
John A. Mandel, Paper by 330
Lichens and recent conceptions of species 442
Life-cycle, Protozoan 507
insurance, Honest, safe and economical 488
Lignites of the Northwest, Study of the 322
Limestone, Overlap of the St. Stephens on the lower tertiary formations in Crenshaw and Pike counties, Ala. 376
Lincoln, S. T., Paper by 336
Livingston, B. E., and F. K. Cameron, Papers by . . 316, 319
Lloyd, F. E., Paper by 441
Long, J. H., Paper by 324
Lolium temulentum, The affinities of the fungus of . . . 442
Longden, A. C., Paper by 293
Loud, F. H., Paper by 250
Lumbriculus Grube, An American species of 410
Lupin seedlings, The influence of aluminium compounds on . . 328
Mabery, C. F., Paper by 322
McFarlane, D. F., and H. P. Cody, Paper by 334
McKelway, A. J., Paper by 484
Macleod, J. J. R., and H. D. Hoskins, Paper by 330
MacNair, F. W., Papers by 287, 349
Magie, Wm. F., Paper by 257
Magnesium sulphate, The solubility of gypsum in solutions of . 336
Man, the scientific, The popular conception of, at the present day 213
Mandel, John A., and P. A. Levene, Paper by 330
Manufactures, The census returns on 489
twelfth census of 490
Massey, W. F., Paper by 473
Mathematics and astronomy 235
Mathewson, Chester A. M., Paper by 440
Mechanical science and engineering 337
Mechanics, The relation of to physics 237
Medicine, experimental, Physiology and 495
Meetings and Officers of Association of American Geologists and Naturalists 15
of the Association 16
Members and fellows 41
of the Association 40
new, Committee on 550

PAGE
Mendel, L. B., and E. M. Bailey, Paper by 328
Mendelian character in cattle 410
Mercury still, A new form of 289
Merriam, C. Hart, Papers by 383, 409
Merry, J. F., Paper by 481
Metabolism, protein, in dogs, Experiment to determine the influence of radium bromide on 327
Metals, Action of on complex cyanides in aqueous solution . . 318
heavy, On the specific inductive capacity of solutions of the oleates of the 315
Meter, A new type of frequency 289, 349
Method of standardizing thermometers below zero . . . 335
Methoxy and Ethoxydibromphenanthrenes and some of their isomers 333
Meyer, G. M., Paper by 327
and R. B. Opitz, Paper by 327
Miller, Dayton C., and Edward W. Morley 289
G. A., Paper by 251
Louise Klein, Paper by 475
Mississippi river water, Filtration and purification of at New Orleans 318
Molecular absorption 316
Mörner Sjiqvöst and Braunstein methods for determining urea, The influence of salicylic acid on the excretion of urea and uric acid and a comparison of the 325
Moore, C. C., Paper by 319
Morley, Edward W., and Dayton C. Miller, Paper by . . . 289
Morphology and embryology of the Nympheacæ, Notes on the . 440
Mosquito extermination, The practical side of . . . 507, 523
Mosquitoes, Without there can be no yellow fever . . 507, 530
Mouse tumors, The influence exerted by chemical and physical agents on the virulence and speed of development of . . 325
Mucoid, On the biological relationship of nucleoproteid amyloid and 330
Mucous membrane, nasal, On the chemical composition of the . 332
Munson, L. S., Paper by 322
T. V., Paper by 437
Mutation a factor in the evolution of the higher vertebrate 383, 409
Mycological Nomenclature, Ramularia, An illustration of the present practice in 443
society, American, Papers presented . . . 442
Nasal mucous membrane, On the chemical composition of the . 332
Nectar glands of Vicia faba, Structure and cytological changes accompanying secretion in 442

PAGE

Negro problem in the United States, Industrial training and . 476
Negroes of Virginia, Progress of, as property owners . . . 478
New form of mercury still 289
members, Committee on 550
Orleans meeting, Council of 7
Local committees of 8
Officers of 5
New straight in non-Euclidean geometry 249
New York meeting, Council for 12
Officers for 10, 555
Newcomb, H. T., Paper by 481
Niagara Falls, Resolution to save 550, 552
Nichols, Edward L., Paper by 290
Nipher, Francis E., Paper by 288
Nitrogenous material, The cutaneous excretion of . . . 328
Noguchi, H., Paper by 329
and S. Flexner, Paper by 329
Nomenclature, mycological, Ramularia; An illustration of the present practice in 443
North American gill fungi 442
species of Peridermium 440
Northwest, Study of the lignites of the 322
Noturus and Schilbeodes, The poison glands of 411
Nucleoproteid, amyloid and mucoid, On the biological relationship of 330
Nugent, P. C., Paper by 293, 351
Nympheacæ, Note on the morphology and embryology of the . 440
Officers for Ithaca and New York meeting 10, 555
of meetings of Association 17
and meetings of Association of American geologists and naturalists 15
of Section A 236
B 256
C 296
D 338
E 356
F 382
H 416
H 446
I 458
K 496
Old age in brachiopods 379
Oleates of the heavy metals, On the specific inductive capacity of solutions of the 315

PAGE
On the use of the words synclinorium and anticlinorium, . . 375
Opitz, R. B., and G. M. Meyer, Paper by 327
Oranges, The ripening of 320
Organic and inorganic chemistry 332
Osborn, Herbert, Paper by 412
Osteology and relationships of the Percopsidæ 411
Our commercial relations with Latin America 492
Overlap of the St. Stephens limestone on the lower tertiary formations in Crenshaw and Pike counties, Ala. . . 376
Pachyma cocos, Notes on 443
Panama, A sea-level canal 294
Discussion of present conditions and the prospect . 294, 352
canal, Observations on 353
Parasite of man, A new bothriocephalid 410
Parasites, Filaria loa, a study on the dispersal of . . . 409
Parr, S. W., Paper by 322
Partition of energy, ... 257
Patrons 40
Paving material, Comparison of methods used in determining total soluble bitumen in 321
Payne, Bruce R., Paper by 491
Penicillium glaucum on pineapple fruit 443
Peptone, Concerning 331
Peptones, The separation of preoteoses and from the simpler amido bodies 325
Percentage bridge 293
Percopsidæ, The osteology and relationships of the . . . 411
Peridermium, North American species of 440
cerebrum Peck and Cronartium quercum (Berkeley) 442
Permanent secretary, Report of 560
Persimmons, The growth and ripening of 320
Petroleum from American fields—Pennsylvania, Ohio, Texas, Kansas, Wyoming, Colorado, Kentucky and California, The composition of 322
Louisiana, Some hydrocarbons in 332
Phelps, E. B., Paper by 318
Phosphate, Absorption of by soils 316
Phosphoric acid of the soil, Availability of the 318
Photographs, Solar 250
Phylogeny, Insect, The problem of wing origin and its significance in 412
Physical chemistry 314, 335
Physics 255
The relation of mechanics to 237
Physiological effects of changes in water density and salinity on fishes 411

PAGE
Physiology and experimental medicine 495
Phytogeography of Florida 439
Pietrzycki, M., Paper by 490
Pig's spleen, On the decomposition of thymus nucleic acid by an extract of 331
Pineapple fruits, Penicillium glaucum on 443
Pinene and firpene, The chlor-hydrochlorides of 333
Plant growth, On the presence in soil and subsoils of substances deleterious to 319
Plants, The effect of the rays of radium on 326
Poison glands of Noturus and Schilbeodes 411
Policy of the Association, Report of committee on 553
Pollen tube in Houstonia cærulea, The behavior of the . . 440
Pond, R. H., Paper by 328
Popular conception of the scientific man at the present day, The 213
Porcelain dishes, The use of in silicate analyses 334
Porter, J. L., Paper by 318
Possibilities of cotton, warehousing from the producer's standpoint 471
Possible extension of the theory of envelopes 252
Postal savings system, Currency reform and 490
Post-eocene and some other formations of the Gulf region of the United States, On some 357
Potassium, Absorption of by soils 317
Powers, L. G., Paper by 488
Practical results of Reed's findings on yellow fever transmission 507, 513
side of mosquito extermination 507, 523
Preliminary observations on the variation of Utethesia venusta, Dalman 409
Preoteoses and peptones, The separation of from the simpler Amido bodies 325
Preservation of Niagara Falls, Resolution on 552
President, Address of the retiring 213
Pressure, barometric, and carbon dioxide, The relation between . 324
Price of sugar, Factors determining the 472
Priming caused by poor circulation in a boiler 293, 351
Problem of wing origin and its significance in insect phylogeny . 412
Progress of the negroes of Virginia as property owners . . 478
Proposed solutions of the railway rate problem 481
Protein metabolism in dogs, Experiments to determine the influence of radium bromide on 327
Protozoan life-cycle 507
Public education in Texas 471
Pueblo environment 447
Purine bodies, On the decomposition of by animal tissues . . . 330
Quantitative estimation of salicylic acid 319

PAGE
Quinn, J. J., Paper by 251
Race degeneracy 486
Radioactivity of the organs of dogs after administration of radium bromide 327
Radium, Experiments to determine the effects of on minute animals 326
The effect of the rays of on plants 326
bromide, The effects of intravenous injection of, in dogs . 327
bromide, experiments to determine the influence of, on protein metabolism in dogs 327
bromide, The radioactivity of the organs of dogs after administration of 327
Railway, Methods of developing traffic, industry and immigration by a modern 481
conditions in Texas 479
rate problem, Proposed solutions of the 481
system, The service waters of a 322
Ramularia; an illustration of the present practice in mycological nomenclature 443
Rat, The activity of the white, at different ages 411
Reasons for desiring a better classification of the Uredinales, Some 442
Reed, H. D., Papers by 411
Reed's findings on yellow fever transmission, The practical results of 507, 513
Relation between the concentration of hydroxyl ions and the rate of tryptic digestion in dilute solutions of various bases 331
nerves of taste and touch in fishes . . 412
of carbon dioxide excretion to body weight . . . 324
higher education to the economic development of the South 473
mechanics to physics 237
schools to civic improvement 475
forestry to soil and climate 471
Report of Committee on amendments 553
an Appalachian forest reserve . . 552
electrochemistry 551
grants 551
policy of the Association . . . 553
resolutions 552
the study of blind invertebrates . . 550
the General Secretary 543
Permanent Secretary 560
Treasurer 556
Resolutions, Reports on 552

PAGE
Resorcinol, Heat of dilution of, in alcoholic solutions . . . 336
Restriction of European immigration 482
Rice, William North, Paper by 375
mills, Utilization of the by-products of the cane sugar and . 474
Richards, J. W., Paper by 315
T. W., and R. C. Wells, Paper by 335
F. G. Jackson, Paper by 335
Richardson, Harriet, Paper by 411
Ring formation in artificial cultures 440
Ripening of oranges 320
Robinson, B. L., Address by 417
Rock decomposition, Electrolysis and endosmosis in the study of . 318
Rolfs, P. H., Papers by 439, 442, 443
Rubinow, I. M., Paper by 483
Russell, B., and Wm. J. Gies, Paper by 332
Russia, The Jews in, Their economic and social position . . 483
Rutherford, T. A., and P. B. Hawk, Paper by 332
Rutter, Frank R., Paper by 472
St. Stephens limestone, The overlap of on the lower tertiary formations in Crenshaw and Pike counties, Ala. . . . 376
Salant, Wm., Paper by 330
Salicylic acid, The influence of on the excretion of urea and uric acid, and a comparison of the Mörner Sjiqvöst and Braunstein methods for determining urea 325
Quantitative estimation of 319
Salt, The secretion of by the leaves of Spartina stricta . . 437
Salts, copper in irrigation waters: a trade waste supply . . 318
of casein, Investigation on 324
Sampling and analysis of coal, Note on 322
Sanitary science and sanitary administration, The experimental method in 497, 507
value of a water analysis 297
Savings system, postal, Currency reform and 490
Schilbeodes, The poison glands of Noturus and 411
School, public high, The social service of in the South . . 491
Schools, Relation of to civic improvement 475
rural, Teaching agriculture in 473
Schreiber, J. H. A., and P. H. Walker, Paper by . . . 320
Schreiner, Oswald, and G. H. Failyer, Papers by . . 316, 317
Schwartz, David, Paper by 321
Science, sanitary, and sanitary administration, The experimental method in 497, 507
Social and economic 457
Scientific man at the present day, The popular conception of . 213

PAGE
Secretary, General, Report of 543
Permanent, Report of 560
Secretion of salt by the leaves of Spartina stricta . . . 437
Section A Address of vice-president 237
Officers of 236
Report of the Secretary 249
B Address of vice-president 257
Officers of 256
Report of the Secretary 287
C Address of vice-president 297
Officers of 296
Report of the Secretary 313
D Address of vice-president 339
Officers of 338
Report of the Secretary 349
E Address of vice-president 357
Officers of 356
Report of the Secretary 375
F Address of vice-president 383
Officers of 382
Report of the Secretary 409
G Address of vice-president 417
Officers of 416
Report of the Secretary 437
H Address of vice-president 447
Officers of 446
Report of the Secretary 455
I Address of vice-president 459
Officers of 458
Report of the Secretary 471
K Address of vice-president 497
Officers of 496
Report of the Secretary 507
Sedgwick, William T., Address by 497, 507
Selenium cell, conditions which change the resistance of the . . 291
Self-digestion, Incapacity of the date endosperm for . . . 328
Sellards, E. H., Paper by 378
Separation of preoteoses and peptones from the simpler Amido bodies 325
solutes from solvents by absorbing media . . 316
Service waters of a railway system 322
Shear, C. L., Papers by 442, 443
Shimer, H. W., Paper by 379
Shull, George H., Paper by 438
Silica, The determination of 334

PAGE
Silicate analyses, The use of porcelain dishes in 334
Sink-hole lakes of North Central Florida, Some 378
Skinner, W. W., Paper by 318
Skull of Syndyoceras 378
Slonaker, James Rollin, Paper by 411
Smith, Alexander and R. H. Brownlee, Paper by 314
Eugene A., Papers by 357, 376
Frank, Paper by 410
G. McP., Paper by 318
Snake venom, The action of eosin and erythrosin upon . . . 329
Social and economic science 457
service of the public high school in the South 491
work of the general federation of women's clubs 478
Sodium bromide, The transition temperature of a new fixed point in the thermometric scale 335
Soils, Absorption of phosphate by 316
potassium by 317
Availability of the phosphoric acid of the 318
Solar Photographs 250
Solubility of gypsum in solutions of ammonium sulphate . . 336
magnesium sulphate . . 336
Solutes, Separation of from solvents by absorbing media . . 316
Solutions of the oleates of heavy metals, On the specific inductive capacity of 315
Solvents, Separation of solutes from by absorbing media . . 316
Some hydrocarbons in Louisiana petroleum 332
peculiar fungi new to America 443
problems of agriculture in Texas 474
South, The cotton oil industry of the 321
Relation of higher education to the economic development of the 473
The social service of the public high school in the . . 491
Southern cotton-mill workers, Their condition and needs . . 475
Spalding, Perley, Paper by 443
V. M., Paper by 441
Spartina stricta, The secretion of salt by the leaves of . . 437
Special committees of the Association 13
Specific inductive capacity of solutions of the oleates of the heavy metals 315
Spectra, fluorescence, Note on the distribution of energy in . . 290
Sphæromidæ, Description of a new genus and nine new species of . 411
Spillman, W. J., Paper by 410
Standard samples of iron and steel 322
Steam, The difference in the coefficient of discharge of through a single circular orifice in a plate and through a number of circular orifices in the same plate 350

PAGE
Steam, Difference in the coefficient of discharge of through a single orifice and through a number of orifices near each other . 290
Steel, Standard samples or iron and 322
Steuart, W. M., Paper by 490
Stockard, Charles R., Paper by 442
Stomatal action and transpiration in Fouquieria splendens and Verbena ciliata 441
Stookey, L. B., Paper by 331
Straight, A new, in non-Euclidean geometry 249
Structure and cytological changes accompanying secretion in nectar glands of Vicia faba 442
Studies on the banana 328
Study of blind invertebrates, Report of committee on . . 550
the lignites of the Northwest 322
Sugar, Factors determining the price of 472
Sugar-cane products, The fermentation of 319
Sugars, A uniform method for the determination of reducing . 320
Sulphur, Amorphous 314
An occurence of native in Oconee county, Ga. . . 334
in illuminating gas, A description of improved apparatus and of a modification of Drehschmidt's method for the determination of 322
Sumner, F. B., Paper by 411
Surviving founders 40
Symposium on yellow fever and insect-borne diseases . . . 507
Synclinorium and anticlinorium, On the use of the words . . 375
Syndyoceras, The skull of 378
Taber, W. C., and J. M. Bell, Paper by 336
Tanning material, The extraction of for analysis . . . 320
Taste and touch in fishes, Relations between the nerves of . . 412
Teaching agriculture in rural schools 473
Telephone exchanges, branch, A critical analysis of methods of supplying power to 289, 350
Tetanus toxin, The action of eosin upon, and in tetanus . . 329
Texas, Public education in 471
Railway conditions in 479
Some problems of agriculture in 744
Thermochemistry of chemical combination 315
Thermometers, Method of standardizing, below zero . . . 335
Thermometric scale, A new fixed point in. The transition temperature of sodium bromide 335
Thymus nucleic acid, On the decomposition of by an extract of pig's spleen 331
Todd, David, Paper by 251
and R. H. Baker, Paper by 252

PAGE
Torrey, Harry Beal, Paper by 412
Touch, Relations between the nerves of taste and, in fishes . . 412
Tracy, S. M., Paper by 442
Trade waste supply: Copper salts in irrigation waters . . 318
Traffic, industry and immigration, Methods of developing by a modern railway 481
Transportation and combination 459
Treasurer, Report of 556
Trelease, William, Resolution presented by 550
Trypanosome diseases, Filariasis and 507, 511
Tryptic digestion, The relation between the concentration of hydroxyl-ions and the rate of, in dilute solutions of various bases . . 331
Tumors, The influence exerted by chemical and physicial agents on the virulence and speed of development of mouse . . 325
Twelfth census of manufactures 490
Typewriter ribbons, Notes on 322
Underwood, O. W., Paper by 482
Uniform method for the determination of reducing sugars . . 320
Urea and uric acid, the influence of salicylic acid on the excretion of, and a comparison of the Mörner-Sjiqvöst and Braunstein methods for determining urea 325
Uredinales, Some reasons for desiring a better classification of the 442
Uredineæ of the Gulf states 442
Utethesia venusta, Dalman, Preliminary observations on the variation of 409
Utilization of the by-products of the cane sugar and rice mills . 474
Van't Hoff-Raoult formula 324
Variation of Utethesia venusta, Dalman, Preliminary observations of 409
Veazie, H. A., Papers by 507, 537
Veitch, F. P., and H. H. Hunt, Papers by 320
Verbena ciliata, Stomatal action and transpiration in Fouquieria splendens and 441
Vertebrates, higher, Is mutation a factor in the evolution of the 383
Vicia faba, The structural and cytological changes accompanying secretion in nectar glands of 442
Waldo, F. L., Paper by 294, 352
Walker, P. H., Paper by 320
Walker, P. H., and J. H. A. Schreiber, Paper by 320
Ward, Henry B., Papers by 409, 410, 507, 511
Warner, W. R., Paper by 294
Warner, Worcester R., Paper by 353
Water, Filtration and purification of the Mississippi river, at New Orleans 318

PAGE
A method for the determination of small amounts of copper in 318
analysis, Sanitary value of a 297
density and salinity, The physiological effects of changes in, on fishes 411
of Death Gulch, Yellowstone National Park, Report on . 334
Waters, irrigation, Copper salts in, A trade waste supply . . 318
Weber, F. C., Paper by 325
Weeks, Henry Clay, Paper by 507, 523
Weight, body, Relation of carbon dioxide excretion to . . 324
Weld, L. G., Paper by 352
Welker, W. H. and W. N. Berg, Paper by 327
and Julia A. Emerson, Paper by 331
Wells, R. C. and T. W. Richard, Paper by 335
Wheeler, A. S., Paper by 333
Whiskey, The artificial coloring matter in 320
White, H. C., Paper by 334
J. H., Papers by 507, 513
rat, The activity of, at different ages 411
Why advancing civilization in America increases crime; Some methods of relief 485
Wiley, Harvey W., Paper by 313
Williams, Eugene, Paper by 471
Winchell, N. H., Paper by 378
Wing origin and its significance in insect phylogeny, The problem of 412
Without mosquitoes there can be no yellow fever . . . 507
Women's clubs, Social work of the general federation of . . 478
Woodward, Calvin M., Remarks by 548
Work, Social, of the general federation of womens' clubs . . 478
Writing inks, The examination of 322
Yellow fever, Difficulties of recognition and prevention . 507, 517
Without mosquitoes there can be no . . 507, 530
and other insect-borne diseases, Symposium on . 507
transmission, The practical results of Reed's findings on 507
Ziwet, Alexander, Paper by 237
Zodiacal stars for the epochs 1900 and 1920, A catalogue of 1,607, reduced to an absolute system 250
Zoology 381

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